PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.
   2. Balancing Hydronic Piping Systems:
      a. Constant-flow hydronic systems.
      b. Variable-flow hydronic systems.
      c. Primary-secondary hydronic systems.
   3. HVAC equipment quantitative-performance settings.
   4. Exhaust hood airflow balancing.
   5. Space pressurization testing and adjusting.
   6. Verifying that automatic control devices are functioning properly.
   7. Existing systems TAB.
   8. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including sub mains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.


S. TAB: Testing, adjusting, and balancing.


U. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS


C. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

D. Sample Report Forms: Submit two sets of sample TAB report forms.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by either AABC or NEBB.
   1. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.

B. TAB Conference: Meet with Architect and Owners representatives and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days’ advance notice of scheduled meeting time and location.
   1. Agenda Items:
      b. The TAB plan.
      c. Coordination and cooperation of trades and subcontractors.

C. Coordination of documentation and communication flow. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC’s "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB’s " Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, "Section II, " Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

H. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS
A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner’s operations.

1.7 COORDINATION
A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY
A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and under floor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 "Metal Ducts" division 23 "Nonmetal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA’s "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units; such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following: 7
   1. Permanent electrical-power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Equipment and duct access doors are securely closed.
   5. Balance, smoke, and fire dampers are open.
   6. Isolating and balancing valves are open and control valves are operational.
   7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   8. Windows and doors can be closed so indicated conditions for system operations can be met.
3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
   1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 "Air Duct Accessories."
   2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 "Duct Insulation," Division 23 "HVAC Equipment Insulation," and Division 23 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
   2. Measure fan static pressures as follows to determine actual static pressure:
      a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.

d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

5. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.
   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.

2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
   a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
   a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record final fan-performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Balance variable-air-volume systems the same as described for constant-volume air systems.
   2. Set terminal units and supply fan at full-airflow condition.
   3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
   4. Readjust fan airflow for final maximum readings.
   5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
   6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
   7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
      a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
   8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
      a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
   2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
   3. Set terminal units at full-airflow condition.
   4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
   5. Adjust terminal units for minimum airflow.
   6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Owner, Commissioning Authority and/or Engineer and comply with requirements in Section 232123 "Hydronic Pumps."
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
   a. Monitor motor performance during procedures and do not operate motors in overload conditions.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated pre-settings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer's name, model number, and serial number.
   4. Efficiency rating.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.12 PROCEDURES FOR BOILERS

A. Measure entering- and leaving-water temperatures and water flow.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:
   1. Nameplate data.
   2. Airflow.
   3. Entering- and leaving-air temperature at full load.
   4. Voltage and amperage input of each phase at full load and at each incremental stage.
   5. Calculated kilowatt at full load.
   6. Fuse or circuit-breaker rating for overload protection.
C. Measure, adjust, and record the following data for each steam coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Airflow.
   3. Air pressure drop.
   4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.

3.14 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.15 PROCEDURES FOR EXHAUST HOODS

A. Measure, adjust, and record the airflow of each exhaust hood. Measure airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, explain why, in the report, and explain the test method used.

B. After balancing is complete, do the following:
   1. Measure and record the static pressure at the hood exhaust-duct connection.
   2. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to achieve optimum results.

3.16 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or non-grounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.
3.17 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to be reused.
   1. Measure and record the operating speed, airflow, and static pressure of each air terminal device impacted by demolition, relocation and new work.
   2. Measure and record water flow and pressure of each air terminal device on pipe loops impacted by demolition, relocation and new work.
   3. Measure and record water flow and pressure of existing chiller.
   4. Measure and record water flow of each pump impacted by demolition, relocation and new work.
   5. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   6. Check the condition of filters.
   7. Check the condition of coils.
   8. Check the operation of the drain pan and condensate drain trap.
   9. Check bearings and other lubricated parts for proper lubrication.
  10. Report on the operating condition of the equipment and the results of the measurements taken.
      Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.
   1. New filters are installed.
   2. Coils are clean and fins combed.
   3. Drain pans are clean.
   4. Fans are clean.
   5. Bearings and other parts are properly lubricated.
   6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
   1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.
   2. Compare the indicated water flow of impacted work to the measured water flows and balance systems to meet flow rates of existing systems.
   3. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
   4. If calculations increase or decrease the airflow and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated airflow and water flow rates. If 5 percent or less, equipment adjustments are not required.
   5. Air balance each air outlet.

3.18 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
   2. Air Outlets and Inlets: minus 5 to plus 10 percent.
   3. Heating-Water Flow Rate: 0 to minus 10 percent.
   4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.19 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in “Examination” Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
B. Status Reports: As work progress prepare progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.20 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report’s binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB contractor.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
       a. Indicated versus final performance.
       b. Notable characteristics of systems.
       c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer's name, type, size, and fittings.
   14. Notes to explain why certain final data in the body of reports vary from indicated values.
   15. Test conditions for fans and pump performance forms including the following:
       a. Settings for outdoor-, return-, and exhaust-air dampers.
       b. Conditions of filters.
       c. Cooling coil, wet- and dry-bulb conditions.
       d. Face and bypass damper settings at coils.
       e. Fan drive settings including settings and percentage of maximum pitch diameter.
       f. Inlet vane settings for variable-air-volume systems.
       g. Settings for supply-air, static-pressure controller.
       h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outdoor, supply, return, and exhaust airflows.
   2. Water and steam flow rates.
   3. Duct, outlet, and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Terminal units.

E. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches (mm), and bore.
   i. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches (mm), and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches w.g.
   e. Filter static-pressure differential in inches w.g.
   f. Preheat coil static-pressure differential in inches w.g.
   g. Cooling coil static-pressure differential in inches w.g.
   h. Heating coil static-pressure differential in inches w.g.
   i. Outside airflow in cfm.
   j. Return airflow in cfm.
   k. Outside-air damper position.
   l. Return-air damper position.
   m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch o.c.
   f. Make and model number.
   g. Face area in sq. ft.
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches w.g.
   d. Outside-air, wet- and dry-bulb temperatures in degrees F.
   e. Return-air, wet- and dry-bulb temperatures in degrees F.
f. Entering-air, wet- and dry-bulb temperatures in degrees F.
g. Leaving-air, wet- and dry-bulb temperatures in degrees F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in degrees F.
k. Leaving-water temperature in degrees F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in degrees F.
o. Inlet steam pressure in psig.

G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:
   a. System identification.
   b. Location.
   c. Coil identification.
   d. Capacity in Btuh.
   e. Number of stages.
   f. Connected volts, phase, and hertz.
   g. Rated amperage.
   h. Airflow rate in cfm.
   i. Face area in sq. ft.
   j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):
   a. Heat output in Btuh.
   b. Airflow rate in cfm.
   c. Air velocity in fpm.
   d. Entering-air temperature in degrees F.
   e. Leaving-air temperature in degrees F.
   f. Voltage at each connection.
   g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.
   f. Arrangement and class.
   g. Sheave make, size in inches, and bore.
   h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches w.g.
   c. Fan rpm.
   d. Discharge static pressure in inches w.g.
e. Suction static pressure in inches w.g.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling unit number.
   b. Location and zone.
   c. Traverse air temperature in degrees F.
   d. Duct static pressure in inches w.g.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Test apparatus used.
   d. Area served.
   e. Air-terminal-device make.
   f. Air-terminal-device number from system diagram.
   g. Air-terminal-device type and model number.
   h. Air-terminal-device size.
   i. Air-terminal-device effective area in sq. ft.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary airflow rate as needed in cfm.
   d. Preliminary velocity as needed in fpm.
   e. Final airflow rate in cfm.
   f. Final velocity in fpm.
   g. Space temperature in degrees F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Entering-water temperature in degrees F.
   c. Leaving-water temperature in degrees F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in degrees F.
   f. Leaving-air temperature in degrees F.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
c. Service.
d. Make and size.
e. Model and serial numbers.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):
   a. Static head in feet of head or psig.
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches (mm).
   d. Full-open flow rate in gpm.
   e. Full-open pressure in feet of head or psig.
   f. Final discharge pressure in feet of head or psig.
   g. Final suction pressure in feet of head or psig.
   h. Final total pressure in feet of head or psig.
   i. Final water flow rate in gpm.
   j. Voltage at each connection.
   k. Amperage for each phase.

M. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.
      d. Dates of use.
      e. Dates of calibration.

3.21 INSPECTIONS

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
   2. Check the following for each system:
      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      d. Verify that balancing devices are marked with final balance position.
      e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:
   1. Final test and balance report requires sign off by Owner.
   2. Architect, Owner, Engineer, or Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 20 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
   3. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
4. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

5. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.

6. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
   1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
   2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

E. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

F. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION
Project Manual for
Wayne State University
Gateway Theater Complex
Vol. 1
Detroit, Michigan
WSU Proj. No. 189-178578
HAA Proj. No. 2016034.00

Owner
Wayne State University
5454 Cass Ave
Detroit, MI 48202

Executive Architect / Landscape Architect
Hamilton Anderson Associates
1435 Randolph, Suite 200
Detroit, MI 48226

Design Architect / MEP Engineer
HGA
420 5th Street N., Suite 100
Minneapolis, MN 55401

Structural Engineering
DESAI / NASR Consulting Engineers
6765 Daly Road
West Bloomfield, MI 48322

Civil Engineer
Spalding DeDecker
905 South Blvd. East
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Theatrical / Lighting
Auerback Pollock Friedlander
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New York, NY 10018

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Norwalk, CT 06854

Issued for PERMIT SET
29 JUNE 2020
1.1 DESIGN PROFESSIONALS OF RECORD

ARCHITECT Hamilton Anderson

PLUMBING/ HVAC HGA

ELECTRICAL ENGINEER HGA
29 JUNE 2020 PERMIT SET

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STRUCTURAL DRAWINGS

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PLUMBING DRAWINGS

ELECTRICAL DRAWINGS

SECURITY DRAWINGS

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THEATRICAL DRAWINGS
LIST OF ALTERNATES

Alternate #1 - Full parking lot

Alternate #2 - Shop Loading Dock Scissor Lift (Lift-5) to be located in Loading 1340

Alternate #3 – Add camera in café

Alternate #4 - Multi-Connector for catwalk

Alternate #5 - Add 7400 SF of 2" fiberglass insulation distributed on walls and/or ceiling in the shop space.

Alternate #6 - Remove scissor lift (Lift-5) at Valade Loading dock (Loading 1219).

Alternate #7 - Remove Valade WD FAB-8 flush panels and provide painted gypsum board finish.

Alternate #8 - Deduct alternate for a portion of the new theatrical lighting control system in the Valade - 116163. Refer to TL Documents.

Alternate #9 - Deduct alternate for motorized lineset #4 in the Valade – 116133.

Alternate #10 - Replace WD FAB-4 at Theater with RPG Flutterfree-T, 1-1/32” deep, size per drawing

Alternate #11 – Add acoustic panels to Valade 2nd floor Dressing Room 2123, Lounge 2124 and Dressing Room 2122. BOD – Kinetics SportsBoard Conform, color: to be selected by architect by manufactures standard colors.

Alternate #12 – Add Truss and Chain Motor at Proscenium


Alternate #14 – Owner provided second direct view LED screen. Provide infrastructure in base bid.
SUB SLAB DEPRESSURIZATION SYSTEM

DESIGN DRAWINGS  (VAPOR MITIGATION SYSTEM)

PROJECT SITE:

GATEWAY THEATER COMPLEX
5454 Cass Ave
Detroit, MI 48202

PROJECT DIMENSIONS

A-Z PROJECT NUMBER | 19-0572
BUILDING USE | COMMERCIAL
BUILDING FOOTPRINT | 67,000 FT²
BUILDING FLOORS | 2
TREATMENT AREAS | 6
TREATMENT AREA SIZE | 14,200 FT²
SSD SYSTEMS | 6
EXTRACTION POINTS | 7
DESIGN STANDARD | ANSI/AARST CC-1000
PROJECT BENCHMARK | -0.020"WC
CHEMICALS OF CONCERN | VARIOUS

REVISIONS

DATE | ISSUED FOR
7/18/19 | DRAFT 1- COORDINATION
8/13/19 | REVISION 1
4/9/20 | REVISION 2
JUN. 1, 2020 | 95% CD
JUN. 29, 2020 | PERMIT SET

SHEET INDEX

V0- | GENERAL NOTES AND MATERIAL SCHEDULES
V1- | PILOT TEST LAYOUT
V2- | SSD SYSTEM LAYOUT
V3- | ELECTRICAL LAYOUT
V4- | MONITORING SYSTEM LAYOUT
V5- | SSD SYSTEM DETAILS
V6- | SCHEMATICS AND DIAGRAMS

A-Z SOLUTIONS, INC.
7681 TIM AVE NW
NORTH CANTON, OH 44720

TONY MCDONALD
OHIO MITIGATION SPECIALIST: RS100
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THIS ENTIRE SET OF CONSTRUCTION DRAWINGS WAS ORIGINALLY PUBLISHED IN COLOR. IF THIS TEXT IS NOT DISPLAYED AS GREEN, YOU MAY BE MISSING IMPORTANT DETAILS.
PROJECT DESCRIPTION AND SYSTEM TYPE

THE SCOPE OF WORK IN THIS SECTION INCLUDES PROVIDING ALL WORK, MATERIALS, LABOR, EQUIPMENT AND SUPERVISION NECESSARY TO COMPLETE AN ACTIVE SUB-SLAB DEPRESSURIZATION (SSD) SYSTEM FOR THE ENTIRE FOOTPRINT OF THE BUILDING.

GENERAL REQUIREMENTS

1. THE SSD SYSTEM SHALL BE INSTALLED IN GENERAL ACCORDANCE WITH THE DESIGN AND INSTALLATION STANDARD.
2. MATERIALS AND EQUIPMENT SHALL BE PROVIDED AS PER THE DRAWINGS AND SPECIFICATIONS.
3. MATERIALS AND EQUIPMENT SHALL NOT BE STORED OR USED IN SUCH A MANNER AS TO CREATE UNSAFE CONDITIONS AND SHALL MEET ALL APPLICABLE CODES.
4. WORK WILL BE CONDUCTED IN CLOSE PROXIMITY TO OTHER TRADES, SAFETY CONCERNS ARE A PRIORITY.
5. ATTEMPTS SHOULD BE MADE TO MINIMIZE DUST, NOISE, AND OTHER INCONVENIENCES.
6. ALL SLAB PENETRATIONS SHALL BE SEALED TO REDUCE DRAWING AIR FROM THE INTERIOR OF THE BUILDING. COORDINATE SEALING WITH OTHER TRADES.
7. AS MINIMUM REQUIREMENTS, THE CONTRACTOR SHALL OBSERVE AND FOLLOW ALL APPROPRIATE AND RELEVANT OR APPLICABLE PROCEDURES IDENTIFIED IN APPLICABLE FEDERAL, STATE, AND LOCAL RULES AND REGULATIONS IN CONDUCTING THE WORK.
8. OTHER APPLICABLE REGULATIONS NOT EXPLICITLY INCLUDED IN THESE SPECIFICATIONS SHALL BE ADHERED TO IN CONDUCTING THE WORK.
9. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING NECESSARY PERMITS AND APPROVALS FOR HIS PROJECT RELATED WORK AND FACILITIES.

PROJECT BENCHMARK

THE FINISHED SYSTEM SHALL DEMONSTRATE A MINIMUM DIFFERENTIAL PRESSURE BETWEEN THE SUB SLAB AND INDOOR AIR OF -0.020"WC AT THE LEAST RESPONSIVE MONITORING POINT.

INSTALLATION MATERIALS

SEE SHEET V0-02 FOR A LIST OF SPECIFIED MATERIALS AND AN ESTIMATED NECESSARY QUANTITY TO COMPLETE THE PROJECT.

MATERIAL SUBSTITUTIONS

NO SUBSTITUTIONS ARE ALLOWED WITHOUT THE PRIOR WRITTEN AUTHORIZATION OF THE SYSTEM DESIGN PROFESSIONAL.

CONTRACTOR QUALIFICATIONS

THE PERSON RESPONSIBLE FOR DIAGNOSTIC TESTING, DESIGN, CONSTRUCTION AND ON-SITE SUPERVISION, AS REQUIRED BY THE SPECIFICATIONS, SHALL HAVE SUCCESSFULLY COMPLETED THE REQUIREMENTS OF THE SPECIFICATIONS AND SHALL BE MAINTAINING A CURRENT CERTIFICATION IN THE NATIONAL RADON PROFICIENCY PROGRAM (NRPP) AS A MITIGATION SPECIALIST.

CONTRACTOR EXPERIENCE

CONTRACTOR WILL BE REQUIRED TO SUBMIT EVIDENCE DEMONSTRATING THAT THE CONTRACTOR HAS SUCCESSFULLY DESIGNED AND INSTALLED AT LEAST 5 SSD SYSTEMS OF THE SAME OR SIMILAR TYPE REQUIRED.

ON SITE SUPERVISION

NO WORK AT THE SITE WILL BE PERMITTED WITHOUT THE PRESENCE OF A PERSON POSSESSING A CURRENT VALID MITIGATION SPECIALIST CERTIFICATION WITH THE NRPP.

DESIGN AND INSTALLATION STANDARD

THIS SYSTEM WAS DESIGNED TO MEET OR EXCEED THE 2018 EDITION OF ANSI/AARST CC-1000: SOIL GAS CONTROL SYSTEMS IN NEW CONSTRUCTION BUILDINGS STANDARD. THE FOLLOWING SECTIONS SHALL APPLY TO THIS PROJECT:

1.0 Scope
1.1 General
1.2 Significance of Use
1.3 Applicability
2.0 TERMS AND DEFINITIONS
3.0 REQUIREMENT SUMMARY
3.1 General
3.2 SOIL GAS VENT SYSTEMS REQUIRED
3.4 MATERIALS AND SPECIFICATIONS
4.0 SOIL GAS COLLECTION PLENUMS
4.1 General
4.2 PLENUM SIZE CALCULATIONS
4.3 SOIL GAS VENT SYSTEMS PER PLENUM SIZE
4.4 COLLECTIVE EXPANSES AND PLENUM SIZE
4.5 JOINED PLENUMS
4.6 JOINED SOIL GAS VENT SYSTEMS
4.7 LIMITING PLENUM AND VENT SYSTEM SIZE
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5.2 CLOSE THE SIDES OF THE PLENUMS
5.3 FOUNDATION DRAIN SYSTEMS
5.4 FOOTINGS AND JOINED PLENUMS
5.5 GAS PERMEABLE LAYERS
5.6 DUCT SIZES
5.7 SOIL GAS INFILTRATION AND AIRFLOW CAPACITY
5.8 TEST PORTS
5.9 PRIOR TO CONCRETE OR SOIL GAS RETARDERS
6.0 CLOSE THE TOP OF THE PLENUM
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6.2 CLOSURE OF CONCRETE FLOORS
6.4 SOIL GAS RETARDER MATERIALS/INSTALLATION
6.5 INSPECTION PRIOR TO INDOOR FINISHINGS
7.0 PRESSURE FIELD EVALUATION
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9.4 STRAIGHT LINE TRAJECTORY
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9.9 INCREASE DISTANCES - LARGE SYSTEMS
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10.1 LABELING OR MARKING REQUIRED
10.3 ACTIVATION FOR SSD
12.0 DOCUMENTATION
12.1 OPERATION AND MAINTENANCE PLAN - STAFF
12.2 O&M MANUAL
12.3 CONSIDERATIONS: CHEMICAL VAPOR
ANNEX A: INSPECTIONS FOR COMPLIANCE

CC-1000 STANDARD SPECIFIC REQUIREMENTS

THE FOLLOWING ITEMS LIMIT THE POTENTIAL INSTALLATION CHOICES IN THE STANDARD TO THE REQUIREMENTS OF THE DESIGN PROFESSIONAL.

4.3 SOIL GAS VENT SYSTEMS PER PLENUM SIZE

ALL SOIL GAS COLLECTION PLENUMS IN THIS BUILDING SHALL MEET THE REQUIREMENTS OF TABLE 4.3.3: CREDIT ALLOWANCE FOR AIRTIGHT APPLICATIONS. THE MAXIMUM PLENUM SIZE ALLOWED FOR A 4" RISER PIPE SHALL BE 7,100 FT².

5.1.1 SUB GRADE SURFACE CLOSURE

EXISTING OR CONSTRUCTED MATERIALS THAT SURROUND THE EXTERIOR AND SIDEWALKS OF GAS PERMEABLE LAYERS AND PERMEABLE COMPONENTS OF FOUNDATION DRAIN SYSTEMS SHALL BE EARTHEN MATERIALS THAT CONTAIN MORE THAN 35% SAND, ROCK FRAGMENT FINES, CLAY AND SILT TO RESTRICT PERMEABILITY.

5.2.2 GAS PERMEABLE LAYER CONFIGURATIONS

A MINIMUM 4" LAYER OF MDOT 6AA WHICH CONTAINS NO WASTE PRODUCTS SHALL BE INSTALLED DIRECTLY ABOVE THE SUB GRADE AND BENEATH THE VAPOR BARRIER TO SATISFY THE REQUIREMENTS OF THIS SECTION.

5.6 DUCT SIZING

ALL CONVEYANCE PIPING FOR THE SSD SYSTEM ABOVE AND BELOW GRADE SHALL BE 4" SCH40 PVC.

6.4.1 MATERIALS UNDER CONCRETE SLABS

A 20ML EVOH SHEET APPLIED VAPOR BARRIER WITH AIRTIGHT SEAMS SHALL BE USED ON THIS BUILDING.

6.5 INSPECT FOR CLOSURE PRIOR TO FINISHING

IMMEDIATELY AFTER INSTALLATION, ARTIFICIAL SMOKE SHALL BE PUMPED BENEATH THE BARRIER TO VERIFY THE INTEGRITY OF THE SEAL. ANY LEAKS IN BARRIER SHALL BE REPAIRED AND THE AREA RETESTED UNTIL NO LEAKS ARE FOUND. THE CLIENT AND ENGINEER OF RECORD SHALL BE PRESENT DURING THIS ACTIVITY TO DOCUMENT THE SUCCESSFUL INSTALLATION OF THE BARRIER.

9.0 EXHAUST LOCATIONS

ALL DISCHARGE LOCATIONS SHALL MEET THE REQUIREMENTS FOR VERTICAL DISCHARGE IN THIS SECTION.
### Soil Gas Exhaust Fan

**System:**
- **Make:**
- **Model:**
- **Amps:**
- **Volts:**
- **Frequency:**
- **Flow:**
- **Pressure:**

**Installation:**
- **Panel #:**
- **Circuit #:**
- **System Installed & Maintained By:** A-Z Solutions, Inc.
- **Phone:** 330-915-2650
- **Website:** www.VaporRemoval.com

### Soil Gas Exhaust System Monitoring Panel

**System:** _____________

**Pressure Sensor Component:**

**Electrical Service Disconnect:**

### Soil Gas Control Extraction Point Record

| SSD System # | Extraction Point # | Date Installed | Ple num Size | Valve Setting | Soil Encountered Pressure | A-Z Solutions, Inc.
<table>
<thead>
<tr>
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<td></td>
</tr>
</tbody>
</table>

### System Identification

**Typical Requirements**

**Conveyance Pipe Label:**
- **Material:** Weatherproof Vinyl
- **Use:** Identify SSD System Conveyance Piping.

**Extraction Point Label:**
- **Material:** Weatherproof Vinyl
- **Use:** Records Sub Slab and Initial Operating Conditions at Startup for Future Reference.

**Fan Assembly Label:**
- **Material:** Weatherproof Vinyl
- **Use:** Records Fan Details, Electrical Info and System Operating Conditions at Startup for Future Reference.

**Service Disconnect Label:**
- **Material:** Weatherproof Vinyl
- **Use:** Identifies Electrical Service Disconnect Switch for Each Fan.

**Monitoring Panel Label:**
- **Material:** Weatherproof Vinyl
- **Use:** Identifies Monitoring System Components and Advises Occupant How to Respond to an Alarm.

**Pressure Sensor Label:**
- **Material:** Weatherproof Vinyl
- **Use:** Identifies Pressure Sensor Component.

### TYPICAL REQUIREMENTS

**System Identification**

**Scale:** 6" = 1'

**Label Name:**
- **Conveyance Pipe Label:**
- **Extraction Point Label:**
- **Fan Assembly Label:**
- **Service Disconnect Label:**
- **Monitoring Panel Label:**
- **Pressure Sensor Label:**

**Size:**
- **Conveyance Pipe Label:** 2" X 4"
- **Extraction Point Label:** 3" X 4"
- **Fan Assembly Label:** 4" X 6"
- **Service Disconnect Label:** ½" X 2"
- **Monitoring Panel Label:** 2" X 4"
- **Pressure Sensor Label:** ¾" X 2"

**Material:**
- WEATHERPROOF VINYL

**Quantity:**
- Place one label per 20' of piping. At least one label on exposed piping in any room.
- Place one label at every extraction point below balancing valve.
- Place one label at every fan assembly.
- Place one label on each electric disconnect housing.
- Place one label on the front panel of each monitoring panel.
- Place one label on the front panel of each pressure sensor.

### Notes

- May contain volatile hazardous substances. Do not alter or disconnect. Not a plumbing line. Piping for vapor mitigation system.
- Do not alter or disconnect. Not a plumbing line for vapor mitigation system.
- If alarm sounds, please call (company name) at (installer phone) for deactivation code and to schedule service.
**TYPICAL REQUIREMENTS**

### MATERIAL SPECIFICATION TABLE

<table>
<thead>
<tr>
<th>USE</th>
<th>PRODUCT</th>
<th>TYPICAL MANUFACTURER</th>
<th>MODEL</th>
<th>ESTIMATED QUANTITY</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FAN ASSEMBLIES AND ACCESSORIES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>EXHAUST FAN</td>
<td>490CFM @ 0.5&quot; FAN ASSEMBLY</td>
<td>FANTECH</td>
<td>RN4-EC</td>
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<td>EACH</td>
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<tr>
<td>PIPE TO FAN COUPLING</td>
<td>RUBBER COUPLING WITH WORM DRIVE CLAMPS</td>
<td>FERNCO</td>
<td>1006-44</td>
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<td>EACH</td>
</tr>
<tr>
<td>MINIHELIC COUPLING</td>
<td>CUSTOM BUSHING</td>
<td>A-Z SOLUTIONS</td>
<td>4X2BDW</td>
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<td>EACH</td>
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<tr>
<td>SYSTEM OPERATING PRESSURE MONITOR</td>
<td>0-5&quot; MINIHELIC GAGE</td>
<td>Dwyer Instruments</td>
<td>2-5005</td>
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<td>EACH</td>
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<tr>
<td>REFERENCE TUBING FOR MINIHELIC GAGE</td>
<td>5/16&quot; OD MINIHELIC TUBING</td>
<td>Eastman</td>
<td>98562</td>
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<td>LF</td>
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<tr>
<td><strong>CONVEYANCE PIPE AND ACCESSORIES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONVEYANCE PIPE</td>
<td>4&quot; SCH40 PVC PIPE AND FITTINGS</td>
<td>VARIOUS</td>
<td>VARIOUS</td>
<td></td>
<td>LF</td>
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<tr>
<td>CONVEYANCE PIPE</td>
<td>6&quot; SCH40 PVC PIPE AND FITTINGS</td>
<td>VARIOUS</td>
<td>VARIOUS</td>
<td></td>
<td>LF</td>
</tr>
<tr>
<td>EXTERIOR PIPE FASTENERS</td>
<td>4&quot; TUBE HOLE STRAP</td>
<td>Radaonawy</td>
<td>67107</td>
<td></td>
<td>EACH</td>
</tr>
<tr>
<td>INTERIOR PIPE FASTENERS</td>
<td>SNAP IN CLAMP J-HOOK OR 2 HOLE STRAP</td>
<td>VARIOUS</td>
<td>-</td>
<td></td>
<td>EACH</td>
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<tr>
<td>PVC PIPE JOINT GLUE</td>
<td>GORILLA PVC CEMENT</td>
<td>Gorilla PVC</td>
<td>MEDIUM SET</td>
<td></td>
<td>16 OZ CAN</td>
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<tr>
<td>PRESSURE BALANCING VALVE</td>
<td>3&quot; GATE VALVE - SLIP CONNECTIONS</td>
<td>Valterra</td>
<td>4301</td>
<td></td>
<td>EACH</td>
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<tr>
<td>CONVEYANCE PIPE ROOF PENETRATION SEAL</td>
<td>ROOF FLASHING</td>
<td>Genova</td>
<td>14564</td>
<td></td>
<td>EACH</td>
</tr>
<tr>
<td>SCREEN TO PREVENT OBJECTS FROM ENTERING EXHAUST</td>
<td>EXHAUST SCREEN</td>
<td>Radaonawy</td>
<td>76041-2</td>
<td></td>
<td>EACH</td>
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<tr>
<td>SMOKE/FIRE SEAL AT FLOOR WALL PENETRATIONS</td>
<td>FIRESTOP SEALANT</td>
<td>Specified Technologies</td>
<td>LC300</td>
<td></td>
<td>10.1 OZ TUBE</td>
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<tr>
<td>FIRE RATED ASSEMBLY AT REQUIRED FLOORS/WALLS</td>
<td>FIRESTOP COLLAR</td>
<td>Specified Technologies</td>
<td>LC400</td>
<td></td>
<td>EACH</td>
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</tbody>
</table>

### MONITORING SYSTEM AND ACCESSORIES

- CENTRAL MONITORING STATION CONTROL PANEL: NETWORK MONITORING STATION
- SLAB MONITORING POINT: BRASS VAPOR PIN
- SLAB MONITORING POINT CONCRETE SEAL: VAPOR PIN SILICONE SLEEVE
- SLAB MONITORING POINT BARB CAP: VAPOR PIN CAP
- SUB SLAB ENCLOSURE MOUNT: 12" x 12" x 2" CONCRETE PAVER
- SUB SLAB MONITORING POINT ENCLOSURE: 6" x 6" x 4" PVC JUNCTION BOX
- PRESSURE RELAY TUBING: 3/8" PVC TUBING
- RELAY TUBING PROTECTION: 1" PVC CONDUIT
- RELAY TUBING PROTECTION: 2" PVC CONDUIT
- SYSTEM OPERATING PRESSURE GAGE: 0-3" MINIHELIC
- MONITORING POINT BARB ENDS FOR ENCLOSURE: 1/4" BARB X FIP

### UNDERGROUNDS

- VAPOR COLLECTION MATING: 15" X 8" VAPORMAT
- VAPOR BARRIER: 20 MIL EVOH VAPOR BARRIER
- VAPOR BARRIER BOTTOM SEAM TAPE: BUTYL SEAM TAPE
- VAPOR BARRIER MIDDLE SEAM: RTV SILICONE
- VAPOR BARRIER TOP SEAM TAPE: VAPOR BOND TAPE
- PENETRATION FLASHING TAPE: VAPOR BOOT TAPE
- SECURE VAPOR BARRIER TO WALLS/PIERS: TERMINATION BAR
- FASTEN TERMINATION BAR TO WALLS/PIERS: HEX HEAD CONCRETE SCREW
- GENERAL SEALING: WHITE LATEX CAULKING
- SEAL CHANNEL DRAIN TOP AT CONCRETE: RTV SILICONE

---

**NOT FOR CONSTRUCTION**

---

**DRAFT**

---

**APENDIX A**

---
NOTE: ADJUSTMENTS TO VENT MATTING LAYOUT TO BE MADE IN THE FIELD TO AVOID PLUMBING AND OTHER MECHANICAL PENETRATIONS IN THE SLAB.
SECTION DETAIL
STADIUM SEATING AND ORCHESTRA PIT

WATERPROOFING SYSTEM
(SEE DETAIL 3/V5-03)

AGGREGATE LAYER
MIN 4" MDOT 6AA
CONTAINING NO WASTE PRODUCTS

NOTE: FILL NOT SHOWN FOR CLARITY

4" SCH40 PVC PIPE

VAPOR COLLECTION MATTING

VAPOR BLOCK PLUS 20 VAPOR BARRIER

NOTE: FILL NOT SHOWN FOR CLARITY
KEY MAP

KEY MAP

LEGEND

0.75" PVC CONDUIT
1" PVC CONDUIT
1.5" PVC CONDUIT
2" PVC CONDUIT

Vapor Pins

Vapor Pins

Foundation Plan

Scale: 1/16" = 1'

SSD Monitoring System

Foundation Plan

V4-01

Not for Construction
VENT MAT STAPELS

VENT MAT CORNER JOINT
SCALE: 3/4" = 1'

VENT MAT END LAP
SCALE: 3/4" = 1'

VENT MAT TEE JOINT
SCALE: 3/4" = 1'

VENT MAT STAPLES

TAPE

VENT MAT

VENT MAT

TAPE

VENT MAT

TAPE

VENT MAT

CONCRETE

VENT MAT

VAPOR BLOCK PLUS 20 VAPOR BARRIER
BY RAVEN INDUSTRIES
OR EQUIVALENT

AGGREGATE LAYER
MIN 4" MDOT 6AA CONTAINING
NO WASTE PRODUCTS

FINAL SUB GRADE PER
PROJECT GEOFICIAL
REPORT

DRAFT
NOT FOR CONSTRUCTION

V5-01

Sheet Number:

DATE:

PLOT DATE/TIME: 4/15/2020 8:46 AM          LAYOUT: V5-01         USER: Griner, Gregory

Project:

EVENT:

8/13/19 REV-1
4/9/20 REV-2

NRPP Cert# 107330

Gateway Theater Complex
Wayne State University
5454 Cass Avenue
Detroit, MI 448202

Drawn By: H. Campbell Date: 7/18/19

Job Number: 19-0572

THIS ENTIRE SET OF CONSTRUCTION DRAWINGS WAS ORIGINALLY PUBLISHED IN COLOR. IF THIS TEXT IS NOT DISPLAYED AS GREEN, YOU MAY BE MISSING IMPORTANT DETAILS.
TO FAN

SEPERATE GEOTEXTILE FROM MATTING AND INSERT INTO 4" PIPE.

1" X 16" TRANSITION SLOT IN PIPE

TO FAN

SEPERATE GEOTEXTILE FROM MATTING AND INSERT INTO 4" PIPE.

1" X 16" TRANSITION SLOT IN PIPE

TO FAN

SEPERATE GEOTEXTILE FROM MATTING AND INSERT INTO 4" PIPE.

1" X 16" TRANSITION SLOT IN PIPE

TO FAN

SEPERATE GEOTEXTILE FROM MATTING AND INSERT INTO 4" PIPE.

1" X 16" TRANSITION SLOT IN PIPE

TO FAN

SEPERATE GEOTEXTILE FROM MATTING AND INSERT INTO 4" PIPE.

1" X 16" TRANSITION SLOT IN PIPE

TO FAN

SEPERATE GEOTEXTILE FROM MATTING AND INSERT INTO 4" PIPE.

1" X 16" TRANSITION SLOT IN PIPE

TO FAN
TYPICAL DETAIL
VAPOUR BARRIER AT EXTERIOR WALL
SCALE: 1/2" = 1'

1. VAPOR BLOCK PLUS 20 VAPOUR BARRIER BY RAVEN INDUSTRIES OR EQUIVALENT

2. GROUT MASONRY SOLID BELOW FLOOR LINE

3. DOWELS TO MATCH VERTICAL REINFORCEMENT ALTERNATE LEG DIRECTION

CONNECT TO VAPOR BLOCK PLUS 20. SEE DETAIL 3 SHEET V5-02

APRON STIRIES

SSD SYSTEM WILL DROP DOWN THE VERTICAL WALL. WATERPROOFING SHOULD BE UPGRADED TO VAPOUR PROOFING. NO SYSTEM NEEDED UNDER BASEMENT, GEO-SEAL BOND-B OR APPROVED EQUIVALENT

CENTER 4" SCH40 PERFORATED PIPE IN MINIMUM 12" 6AA STONE BACKFILL

TYPICAL DETAIL
VAPOUR BARRIER AT INTERIOR WALL
SCALE: 1/2" = 1'

1. VAPOR BLOCK PLUS 20 VAPOUR BARRIER BY RAVEN INDUSTRIES OR EQUIVALENT

2. VAPOR BLOCK PLUS 20 VAPOUR BARRIER BY RAVEN INDUSTRIES OR EQUIVALENT

3. CONNECT TO VAPOR BLOCK PLUS 20. SEE DETAIL 3 SHEET V5-02

4. SSD SYSTEM WILL DROP DOWN THE VERTICAL WALL. WATERPROOFING SHOULD BE UPGRADED TO VAPOUR PROOFING. NO SYSTEM NEEDED UNDER BASEMENT, GEO-SEAL BOND-B OR APPROVED EQUIVALENT

CENTER 4" SCH40 PERFORATED PIPE IN MINIMUM 12" 6AA STONE BACKFILL

TYPICAL DETAIL
VAPOUR BARRIER AT ORCHESTRA WALL
SCALE: 3/8" = 1'

1. VAPOR BLOCK PLUS 20 VAPOUR BARRIER BY RAVEN INDUSTRIES OR EQUIVALENT

2. GROUT MASONRY SOLID BELOW FLOOR LINE

3. DOWELS TO MATCH VERTICAL REINFORCEMENT (TYP.)

CONNECT TO VAPOR BLOCK PLUS 20. SEE DETAIL 3 SHEET V5-02

APRON STIRIES

SSD SYSTEM WILL DROP DOWN THE VERTICAL WALL. WATERPROOFING SHOULD BE UPGRADED TO VAPOUR PROOFING. NO SYSTEM NEEDED UNDER BASEMENT, GEO-SEAL BOND-B OR APPROVED EQUIVALENT

CENTER 4" SCH40 PERFORATED PIPE IN MINIMUM 12" 6AA STONE BACKFILL

TYPICAL DETAIL
THICKENED SLAB AT TREATMENT AREA BOUNDARY
SCALE: 3/4" = 1'

1. VAPOR BLOCK PLUS 20 VAPOUR BARRIER BY RAVEN INDUSTRIES OR EQUIVALENT

2. VAPOR BLOCK PLUS 20 VAPOUR BARRIER BY RAVEN INDUSTRIES OR EQUIVALENT

3. CONNECT TO VAPOR BLOCK PLUS 20. SEE DETAIL 3 SHEET V5-02

4. SSD SYSTEM WILL DROP DOWN THE VERTICAL WALL. WATERPROOFING SHOULD BE UPGRADED TO VAPOUR PROOFING. NO SYSTEM NEEDED UNDER BASEMENT, GEO-SEAL BOND-B OR APPROVED EQUIVALENT

CENTER 4" SCH40 PERFORATED PIPE IN MINIMUM 12" 6AA STONE BACKFILL

CONNECT 20 MIL VAPOR BARRIER TO 10 MIL VAPOR BARRIER. SEE DETAIL 3 SHEET V5-02

APRON STIRIES

SSD SYSTEM WILL DROP DOWN THE VERTICAL WALL. WATERPROOFING SHOULD BE UPGRADED TO VAPOUR PROOFING. NO SYSTEM NEEDED UNDER BASEMENT, GEO-SEAL BOND-B OR APPROVED EQUIVALENT

CENTER 4" SCH40 PERFORATED PIPE IN MINIMUM 12" 6AA STONE BACKFILL

NOT FOR CONSTRUCTION

END OF TREATMENT AREA

EXTEND 20 MIL VAPOR BARRIER 2' PAST TREATMENT AREA

CONCRETE

20ML VAPOR BARRIER

AGGREGATE LAYER

MIN 4" MDOT 6AA CONTAINING NO WASTE PRODUCTS

FINAL SUB GRADE PER PROJECT GEO-TECHNICAL REPORT

CONNECT 20 MIL VAPOR BARRIER TO 10 MIL VAPOR BARRIER. SEE DETAIL 3 SHEET V5-02

APRON STIRIES

SSD SYSTEM WILL DROP DOWN THE VERTICAL WALL. WATERPROOFING SHOULD BE UPGRADED TO VAPOUR PROOFING. NO SYSTEM NEEDED UNDER BASEMENT, GEO-SEAL BOND-B OR APPROVED EQUIVALENT

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20ML VAPOR BARRIER

AGGREGATE LAYER

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FINAL SUB GRADE PER PROJECT GEO-TECHNICAL REPORT

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CONCRETE

20ML VAPOR BARRIER

AGGREGATE LAYER

MIN 4" MDOT 6AA CONTAINING NO WASTE PRODUCTS

FINAL SUB GRADE PER PROJECT GEO-TECHNICAL REPORT

CONNECT 20 MIL VAPOR BARRIER TO 10 MIL VAPOR BARRIER. SEE DETAIL 3 SHEET V5-02

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SSD SYSTEM WILL DROP DOWN THE VERTICAL WALL. WATERPROOFING SHOULD BE UPGRADED TO VAPOUR PROOFING. NO SYSTEM NEEDED UNDER BASEMENT, GEO-SEAL BOND-B OR APPROVED EQUIVALENT

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EXTEND 20 MIL VAPOR BARRIER 2' PAST TREATMENT AREA

CONCRETE

20ML VAPOR BARRIER

AGGREGATE LAYER

MIN 4" MDOT 6AA CONTAINING NO WASTE PRODUCTS

FINAL SUB GRADE PER PROJECT GEO-TECHNICAL REPORT

CONNECT 20 MIL VAPOR BARRIER TO 10 MIL VAPOR BARRIER. SEE DETAIL 3 SHEET V5-02

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END OF TREATMENT AREA

EXTEND 20 MIL VAPOR BARRIER 2' PAST TREATMENT AREA

CONCRETE

20ML VAPOR BARRIER

AGGREGATE LAYER

MIN 4" MDOT 6AA CONTAINING NO WASTE PRODUCTS

FINAL SUB GRADE PER PROJECT GEO-TECHNICAL REPORT

CONNECT 20 MIL VAPOR BARRIER TO 10 MIL VAPOR BARRIER. SEE DETAIL 3 SHEET V5-02

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NOT FOR CONSTRUCTION

END OF TREATMENT AREA

EXTEND 20 MIL VAPOR BARRIER 2' PAST TREATMENT AREA

CONCRETE

20ML VAPOR BARRIER

AGGREGATE LAYER

MIN 4" MDOT 6AA CONTAINING NO WASTE PRODUCTS

FINAL SUB GRADE PER PROJECT GEO-TECHNICAL REPORT

CONNECT 20 MIL VAPOR BARRIER TO 10 MIL VAPOR BARRIER. SEE DETAIL 3 SHEET V5-02

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NOT FOR CONSTRUCTION

END OF TREATMENT AREA

EXTEND 20 MIL VAPOR BARRIER 2' PAST TREATMENT AREA

CONCRETE

20ML VAPOR BARRIER

AGGREGATE LAYER

MIN 4" MDOT 6AA CONTAINING NO WASTE PRODUCTS

FINAL SUB GRADE PER PROJECT GEO-TECHNICAL REPORT

CONNECT 20 MIL VAPOR BARRIER TO 10 MIL VAPOR BARRIER. SEE DETAIL 3 SHEET V5-02
IF ALARM SOUNDS, PLEASE CALL (COMPANY NAME) AT (INSTALLER PHONE) FOR DEACTIVATION CODE AND TO SCHEDULE SERVICE.

SOIL GAS EXHAUST SYSTEM

PRESSURE SENSOR

SOIL GAS EXHAUST SYSTEM

SSD-1

SYSTEM: _____________

PRESSURE SENSOR

SOIL GAS EXHAUST SYSTEM

SSD-2

SYSTEM: _____________

PRESSURE SENSOR

SOIL GAS EXHAUST SYSTEM

SSD-3

SYSTEM: _____________

PRESSURE SENSOR

SOIL GAS EXHAUST SYSTEM

SSD-4

SYSTEM: _____________

PRESSURE SENSOR

SOIL GAS EXHAUST SYSTEM

SSD-5

SYSTEM: _____________

PRESSURE SENSOR

SOIL GAS EXHAUST SYSTEM

SSD-6


EXTRACTION POINT OPERATING PRESSURE MONITORING POINT PRESSURE MONITORING POINT PRESSURE SWITCH.

CLEVELAND CONTROLS NS-2

ONE FOR EACH FAN.

USE EP-1.1 FOR SSD-1.

110V OUTLET

GE INTERLOGIX NX-8

CENTRAL MONITORING PANEL

CAT 5E NETWORK PATCH CABLE

PRESSURE MONITORING CONTROL BOX

18-3 LOW VOLTAGE WIRE

1 4" BRASS BARB CONNECTED TO MONITORING POINT RELAY TUBING

INSTALL TWO 2" CONDUITS FROM JUNCTION BOX TO MONITORING STATION

8" JUNCTION BOX

ROUTE ALL UNDERGROUND CONDUIT HERE

6" MONITORING WELL MANHOLE COVER

BRASS VAPOR PIN

UNDERGROUND CONDUIT, SEE CONDUIT CHART FOR SIZING

1/2" RELAY TUBING TO ADDITIONAL MONITORING POINTS

12" x 12" x 2" CONCRETE PAVER

SILICONE SLEEVE

ROUTE ALL RELAY TUBING CONDUIT HERE CONTINUE RELAY TUBING TO NEXT MONITORING POINT

TYPICAL DETAIL
MONITORING POINT ENCLOSURE

SCALE: 2" = 1'

TYPICAL DETAIL
MONITORING STATION

SCALE: 1/2" = 1'

128 JANITOR ROOM

EXTRACTION POINT OPERATING PRESSURE MONITORING POINT PRESSURE MONITORING POINT PRESSURE SWITCH.

CLEVELAND CONTROLS NS-2

ONE FOR EACH FAN.

USE EP-1.1 FOR SSD-1.

110V OUTLET

GE INTERLOGIX NX-8

CENTRAL MONITORING PANEL

CAT 5E NETWORK PATCH CABLE

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12" x 12" x 2" CONCRETE PAVER

SILICONE SLEEVE

ROUTE ALL RELAY TUBING CONDUIT HERE CONTINUE RELAY TUBING TO NEXT MONITORING POINT

TYPICAL DETAIL
MONITORING POINT ENCLOSURE

SCALE: 2" = 1'

TYPICAL DETAIL
MONITORING STATION

SCALE: 1/2" = 1'

128 JANITOR ROOM

EXTRACTION POINT OPERATING PRESSURE MONITORING POINT PRESSURE MONITORING POINT PRESSURE SWITCH.

CLEVELAND CONTROLS NS-2

ONE FOR EACH FAN.

USE EP-1.1 FOR SSD-1.

110V OUTLET

GE INTERLOGIX NX-8

CENTRAL MONITORING PANEL

CAT 5E NETWORK PATCH CABLE

PRESSURE MONITORING CONTROL BOX

18-3 LOW VOLTAGE WIRE

1 4" BRASS BARB CONNECTED TO MONITORING POINT RELAY TUBING

INSTALL TWO 2" CONDUITS FROM JUNCTION BOX TO MONITORING STATION

8" JUNCTION BOX

ROUTE ALL UNDERGROUND CONDUIT HERE

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BRASS VAPOR PIN

UNDERGROUND CONDUIT, SEE CONDUIT CHART FOR SIZING

1/2" RELAY TUBING TO ADDITIONAL MONITORING POINTS

12" x 12" x 2" CONCRETE PAVER

SILICONE SLEEVE

ROUTE ALL RELAY TUBING CONDUIT HERE CONTINUE RELAY TUBING TO NEXT MONITORING POINT

TYPICAL DETAIL
MONITORING POINT ENCLOSURE

SCALE: 2" = 1'

TYPICAL DETAIL
MONITORING STATION

SCALE: 1/2" = 1'
**Sub-Slab Vapor Removal System**
This device measures system vacuum pressure. Do not tamper with or disconnect. For service, please call A-Z Solutions 330-888-6063

**COMMUNICATION MODULE**
(LOCATION IN CABINET MAY VARY)

**BATTERY BACK-UP**
(LOCATED IN CABINET, CONNECT TO EXISTING BLACK & RED WIRES FROM MAIN BOARD)
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- 017329 Cutting & Patching
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- 057200 Ornamental Railings

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- 077200 Roof Curbs
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101419  Dimensional Letter Signage
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116135  Stage Extension Pit Lift System
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123551  Music Education Storage Casework  
126100  Fixed Audience Seating  

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- 333100 Sanitary Sewers (*Issued in previous Bid Package*)
- 334100 Strom Sewers, Underdrains and Drainage Structures

**END OF SECTION**
SECTION 014339
MOCKUPS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: General requirements for mockups specified in other technical Sections.
B. Related Sections:
   1. Section 013300 - Submittal Procedures: Sample submittals.
   2. Section 014500 - Quality Control.
   3. Section 014533 - Structural Testing and Special Inspections.

1.2 DEFINITIONS
A. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
   1. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
   2. Integrated Interior Mockups: Mockups of architectural elements and finishes with common adjacencies, with lighting conditions identical to actual finished construction.
   3. Room Mockups: As described in Part 3.

1.3 ACTION SUBMITTALS
A. Mockup Shop Drawings: For integrated exterior wall mockups and integrated mockups of interior assemblies and finishes.
   1. Provide plans, sections, and elevations, indicating materials and size of mockup construction.
   2. Indicate manufacturer and model number of individual components.
   3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.4 MOCKUPS
A. Mockup Pre-Installation Conference: Before beginning mock-up construction and installation, conduct conference with manufacturer’s representatives, fabricators, installers, Architect, Owner and other interested parties to review procedures, schedules, and coordination of curtain wall installation with other elements of Work.
B. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
   2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
   3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
   4. Demonstrate the proposed range of aesthetic effects and workmanship.
   5. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
      a. Allow seven days for initial review and each re-review of each mockup.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

C. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
   1. Notify Architect 7 days in advance of dates and times when mockups will be constructed.
   2. Allow 10 days for initial review and each re-review of each mockup.
   3. Do not start production run for final job site erection until acceptance has been obtained of tested mock-ups.

D. Approved Mockups: Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work. Mockup shall remain on site and shall not be removed, disassembled, or disposed of until so directed by Architect.
   1. Approved in-place mockups may remain as part of final Work.
   2. Maintain stand-alone mockups on site. Do not remove, disassembled, or disposed of until so directed by Architect.

1.5 MOCKUP TESTING

A. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements, comply with requirements specified in individual technical Sections and with the following:
   1. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
   2. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
   3. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
   4. When testing is complete, remove test specimens, assemblies, and mockups; do not reuse products on Project.
   5. Provide test specimens representative of proposed products and construction.
   6. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
   7. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
   8. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
   9. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
  10. When testing is complete, remove test specimens, assemblies, and mockups; do not reuse products on Project.

B. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, through Construction Manager, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

C. Representatives of Architect's office and representatives of Owner's office will be present to observe preparation for testing and testing procedures.
   1. Notify Architect in advance of testing.

D. Testing of Mockups: Conduct tests in accordance with test procedures specified in individual specification Sections.
PART 2 PRODUCTS
Not Used.

PART 3 MOCKUP SCHEDULE

3.1 INTEGRATED EXTERIOR WALL MOCKUP
A. General: Construct integrated exterior mockup according to approved Mockup Shop Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with other supporting materials.
B. Mockup Shop Drawings and Mockup Pre-Installation Conference: As specified herein.
C. Size: As indicated on approved Mockup Shop Drawings, and as follows:
   1. Width: 8'-0" wide, minimum.
   2. Height: Minimum truncated height required to include all elements of full-height wall.
D. Scope: Construct integrated mockup of partial exterior wall as indicated on Detail ______. Include the following wall assembly elements:
   E. Components to Include:
      1. 03 45 00 Architectural Precast
      2. 07 27 00 Air Barrier
      3. 07 42 00 Metal Panels
      4. 07 62 00 Sheet Metal & Flashing
      5. 07 92 00 Joint Sealant
      6. 08 44 00 Curtain Walls, Storefronts & Entrances: Provide mockup of curtain wall system to be field-tested for air and water infiltration
      7. 08 80 00 Glazing: For each glass product indicated, in combination with curtain wall mockup

3.2 INTEGRATED INTERIOR MOCKUP
A. Mockup Shop Drawings and Mockup Pre-Installation Conference: As specified herein.
B. Integrated Interior Mockups: Mockups of architectural elements and finishes with common adjacencies, with lighting conditions identical to actual finished construction.
   1. Refer to Section 064000 - Architectural Woodwork.
   2. Provide all accessories required for sound & vibration control.
   3. Mockup adjacent construction for the purpose of assessing fit and alignment of moveable assembly, and to establish tolerances for final installed Work.
C. (WD FAB-4), (WD FAB-6), (WD FAB-7) and (WD FAB-8) Wood Wall Assemblies:
   2. Scope: As indicated in approved mockup shop drawings.
   3. If system is panelized, include at least 1 vertical and 1 horizontal panel-to-panel joint in mockup.
      a. Type L100 (1) 4ft sample, including fixture and mounting accessories. Purpose of the mock-up is to review the lighting effect, and the appearance of the donor wall signage. Results of mockup may effect fixture location, accessories and/or fixture specification.
      b. Type L151 (1) sample, including fixture and mounting accessories. Purpose of the mock-up is to review the aesthetic integration of the fixture housing with the vertical wood rods at the perimeter walls of the Valade theatre. Results of mockup may effect fixture location, accessories and/or fixture specification.
c. Type L150 (1) sample, including fixture and mounting accessories. Purpose of the mock-up is to review the appearance of the fixture housing with the uneven wall treatment in the perimeter walls of the proscenium theatre. Results of mockup may effect fixture location, accessories and/or fixture specification.

3.3 SPECIFIC MOCKUPS

A. General: Refer to individual specification Sections for specific mockup requirements.

B. 03 30 00 Cast-in Place Concrete
   1. CONC FIN-

C. 05 50 00 Metal Fabrications
   1. MET FAB-14: Catwalk assembly
   2. MET FAB-15: Lighting support rail

D. 05 70 00 Ornamental Metal
   1. ORN MET-4: Metal Ceiling

E. 05 72 00 Ornamental Railings
   1. ORN RAIL-3
   2. ORN RAIL-4
   3. ORN RAIL-6
   4. ORN RAIL-7
   5. ORN RAIL-8

F. 06 40 00 Architectural Woodwork
   1. WD FAB-1
   2. WD FAB-3
   3. WD FAB-4
   4. WD FAB-6
   5. WD FAB-8

G. 09 29 00 Gypsum Board: For level 5 finish.

H. 09 64 00 Wood Flooring: Mockup of wood flooring.

I. 09 67 23 Resinous Flooring: Mockup of Resinous flooring.

J. 09 80 00 Acoustic Treatments: Before installing acoustical wall and ceiling panels, build mockups for each form of construction and finish required to verify selections made.

K. 09 90 00 Painting: For PT-13, demonstrating 2 different paint options for final selection. Mockup shall include mockup of lighting conditions.

L. 10 11 00 Visual Display Boards: To verify selections made.

M. 10 14 14 Custom Illuminated Signage: Mockup for each sign type.

N. 10 14 19 Dimensional Letter Signage: Mockup for each sign type.

O. 12 61 00 Fixed Audience Seating: For each type of audience seat, fabric, finishes and accessories – double seat mockup with 1 light.

P. 27 41 00 Performance AV Systems: Mockup of all system graphical user interface screens and all source code/configuration files.
3.4 OTHER MOCKUPS
   A. In addition to previous items, construct field (project site) mock-ups and samples for review where indicated in individual Specifications Sections.

3.5 INSTALLATION
   A. Installation: Construct mock-ups for Architect's visual examination, for quality control, and performance of required testing. Use materials, fabrication and installation methods identical with those indicated for Work. Simulate surrounding conditions as closely as possible.
      1. Construct mockups for Architect's visual examination, for quality control and quality of installation.
         a. Demonstrate the proposed range of aesthetic effects and workmanship.
         b. Build mockups of size indicated in Drawings.
         c. Use materials, fabrication and installation methods identical with those indicated for Work.
         d. Simulate surrounding conditions as closely as possible.
      2. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
      3. Install mockups under manufacturer's direct supervision employing workmen who will be used during actual erection at job site.

END OF SECTION
SECTION 017329
CUTTING & PATCHING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Cutting, demolition, removal, patching and restoration of work as necessary to accomplish and complete all work under the Contract, including general construction, mechanical and electrical work; except where work is indicated within designated historic areas.

B. Related Sections:
   1. Refer to Sections 011100 and 015100 for special requirements, protection, constraints, timing of work, scheduling of work, enclosures and similar requirements relating to this Section.
   3. Section 024119 - Selective Demolition.

1.2 INFORMATIONAL SUBMITTALS
A. Schedule: Submit schedule indicating proposed sequence of operations for demolition work to Owner's Representative for review prior to start of work. Include coordination for shutoff, capping, and continuation of utility services as required, together with details for dust and noise control protection.

   1. Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of Owner's on-site operations. Coordinate with Work of other related Sections.

1.3 QUALITY ASSURANCE
A. Skilled Mechanics: Accomplish all work of cutting, removal, demolition, relocation, patching and other restoration by using only mechanics skilled in the trade. If necessary, sublet the work to skilled contractors or subcontractors.

1.4 COORDINATION
A. Coordinate all work of this Section with all subcontractors so the work will progress without interruption and minimum delays.

B. Coordinate and schedule work of this Section with the Owner where possible disturbance may occur and where relocations or other potential disruptions of the Owner's functions and services may occur. All work affecting the Owner's functions and services shall be performed at times acceptable to the Owner.

C. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 DISPOSITION OF MATERIALS

2.1 UNSALVABLE MATERIALS
A. Remove unsalvable materials in a manner that will avoid damage to materials or equipment which will remain. Completely remove and legally dispose of away from the site.
2.2 SALVABLE MATERIALS TO BE RE-USED IN WORK
   A. Salvable materials and items designated for reuse or relocation, such as brick, millwork, or equipment shall be removed by the applicable trades and relocated to the new location or stored and protected from damage until incorporated into the new work.
   B. Carefully remove, salvage, clean and preserve materials, equipment and other items indicated to be reused, or which will be needed for reuse to match existing work.
   C. Exercise extreme care in removals to prevent damage or to make materials unsuitable to reuse.
   D. For materials shown or called for to be reused and which are damaged, replace with equivalent and matching work.

PART 3 EXECUTION

3.1 DESCRIPTION OF WORK
   A. Drawings generally indicate the extent of demolition, removals, relocations and cutting. The drawings shall not be construed as indicating all required work, nor indicating all conditions or details which might be encountered to accomplish the work of this Contract. The Contractor and subcontractors must examine the spaces themselves to determine the actual conditions and requirements.

3.2 TEMPORARY PROTECTION
   A. Provide temporary bracing, shoring, needling and support during demolition, cutting, remodeling and related new construction as necessary for the execution of the Work and the protection of persons and property. Perform all work with appropriate supports, protection and methods to prevent collapse, settling or damage to property or persons. Provide adequate supports for the loads to be carried, with loads properly distributed, including to lower levels and sound bearing, if necessary.
   B. Protection: Protect in-place construction during cutting and patching to prevent damage.
      1. Provide protective coverings and enclosures necessary to prevent damage to existing spaces and materials to remain.
      2. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
      3. Provide dustproof temporary enclosures separating areas under demolition and remodeling from the remainder of the building as well as temporary HEPA filters at ductwork.
      4. Provide temporary hinged doors in temporary enclosures where necessary. Temporary and permanent doors shall be completely sealed with tape or other suitable material during demolition work and shall remain sealed until dust has settled.
   C. Limit dust, dirt and noise dispersal to the lowest practical level. Comply with governing regulations regarding environmental hazards and general dust control. Notify the Owner’s representative of possible exposure to harmful dusts and vapors, flammable or explosive materials, and other potential hazards.

3.3 CUTTING AND REMOVING
   A. Perform cutting, demolition, removal work, patching and restoration of work as necessary to accomplish and complete all work under the Contract, including any relocation or reuse of existing materials, equipment, systems, or other work, as well as the disposition of salvaged materials or debris.
1. Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
2. Beginning of cutting or patching means acceptance of existing conditions.
3. Provide protective coverings and enclosures necessary to prevent damage to existing spaces and materials to remain.
4. Demolish and remove existing construction as shown, indicated or required to be removed to accomplish the Work.
5. Execute work with care. Existing construction that is to remain which is loosened, cracked, or otherwise damaged or defaced as a result of the Work and is unsuitable for use intended shall be removed and replaced at no additional cost to the Owner.
6. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
7. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
8. Transport debris and rubbish in such a manner as to prevent the spread of dust.
9. Clean demolition areas and remove debris, waste and rubbish from the building at the conclusion of each day's work.
   a. Transport debris and rubbish in such a manner so as to prevent spread of dust.
   b. Do not store or permit debris storage at site.
   c. Do not burn debris, rubbish or waste at the site.
   d. Keep adjacent areas unencumbered and clean.
   e. Keep walks and similar areas broom clean.

3.4 PATCHING AND RESTORING

A. Patch or otherwise restore disturbed existing construction as indicated on the drawings and schedules, or as otherwise required to restore the work and surfaces. Patching or restoration shall be carried to natural breaks (i.e., corners) wherever possible. Where existing construction is removed, cut or otherwise disturbed by Work of the Project, patch defective and incomplete surfaces. Repair any damage to existing construction which is to remain.
   1. Patching work shall be done by skilled mechanics experienced in the particular type of work involved. Patching work shall conform to the standards of the Specifications where applicable and where not specified, work shall conform to the highest standards of the trade.
   2. Patch existing construction to match existing work (unless otherwise called for) except provide new materials and accomplish as for new work. Examine existing surfaces to be patched before proceeding with the work. Report all conditions where existing materials, colors and finishes cannot be matched to the Architect and Owner, and do not proceed until instructions have been given.
   3. Existing construction that has been damaged as a result of the Work shall be repaired to an extent and as required to match adjacent existing undamaged construction.
   4. Painting: Painting, including preparation, materials, workmanship and number of coats shall comply with Section 099000 - Painting. Painting of surfaces patched shall extend to natural breaks, such as corners, as approved by the Architect and Owner.
      a. It is the intent that the mechanical and electrical subcontractors are responsible to paint or repaint surfaces at locations where demolition, cutting and patching has been accomplished only for their work.

B. Thoroughly clean and prepare all surfaces to receive new finish or covering. Completely remove dirt, dust, grease, oil, paint, loose materials and soil. Clean, etch where necessary, and place surfaces in most suitable condition for the finish.
3.5 CLEANING

A. Perform periodic and final cleaning.
B. Clean Owner-occupied areas daily.
C. Clean spillage, overspray, and heavy collection of dust in Owner-occupied areas immediately.
D. At completion of work of each trade, clean area and make surfaces ready for work of successive trades.
E. At completion of alteration work in each area, provide final cleaning and return space to a condition suitable for use by Owner.

END OF SECTION
SECTION 017900
DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.1 SUMMARY
A. Section includes administrative and procedural requirements for instructing Owner’s personnel, including the following:
   1. Demonstration of operation of systems, subsystems, and equipment.
   2. Training in operation and maintenance of systems, subsystems, and equipment.
   3. Demonstration and training video recordings.

1.2 APPLICATION OF SPECIFICATION SECTION
A. Specification section applies to Divisions 21, 22, 23, 26 and 28—respectively Fire Protection, Plumbing, Mechanical and Electrical. The specific sections where this applies per division is below:
   1. Division 21
      a. 211313 Wet-Pipe Sprinkler Systems
   2. Division 22
      a. 221429 Sump Pumps
      b. 223400 Fuel-Fired, Domestic-Water Heaters
   3. Division 23
      a. 230514 Variable-Frequency Motor Controllers
      b. 230900 Building Automation Systems
      c. 230993 Sequence of Operation for HVAC Controls
      d. 235216 Condensing Boilers
      e. 236423 Screw Water Chillers
      f. 237316 Air-Handling Units
      g. 238123 Computer-Room-Air-Conditioning Units
      h. 238126 Split-System Air-Conditioning Units
      i. 238413 Humidifiers
   4. Division 26
      a. 260913 Electrical Power Monitoring and Control
      b. 260923 Lighting Control Devices
      c. 260943 Distributed Digital Lighting Controls
      d. 262713 Electricity Metering
      e. 263213.16 Gaseous Emergency Engine Generators
      f. 265119 LED Interior Lighting
   5. Division 28
      a. 283111 Digital, Addressable Fire-Alarm System

B. These demonstration and training requirements are in addition to those listed elsewhere in the project.

1.3 INFORMATIONAL SUBMITTALS
A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors’ names for each training module. Include learning objective and outline for each training module.
1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

B. Attendance Record: For each training module, submit list of participants and length of instruction time.

C. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
   1. Identification: On each copy, provide an applied label with the following information:
      a. Name of Project.
      b. Name and address of videographer.
      c. Name of Architect.
      d. Name of Construction Manager.
      e. Name of Contractor.
      f. Date of video recording.
   2. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
   3. At completion of training, submit complete training manual(s) for Owner's use prepared and bound in format matching operation and maintenance manuals and in PDF electronic file format.

1.5 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.

C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.

D. Preinstruction Conference: Conduct conference at Project site. Review methods and procedures related to demonstration and training including, but not limited to, the following:
   1. Inspect and discuss locations and other facilities required for instruction.
   2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
   3. Review required content of instruction.
   4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
   a. System, subsystem, and equipment descriptions.
   b. Performance and design criteria if Contractor is delegated design responsibility.
   c. Operating standards.
   d. Regulatory requirements.
   e. Equipment function.
   f. Operating characteristics.
   g. Limiting conditions.
   h. Performance curves.

2. Documentation: Review the following items in detail:
   a. Emergency manuals.
   b. Operations manuals.
   c. Maintenance manuals.
   d. Project record documents.
   e. Identification systems.
   f. Warranties and bonds.
   g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:
   a. Instructions on meaning of warnings, trouble indications, and error messages.
   b. Instructions on stopping.
   c. Shutdown instructions for each type of emergency.
   d. Operating instructions for conditions outside of normal operating limits.
   e. Sequences for electric or electronic systems.
   f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:
   a. Startup procedures.
   b. Equipment or system break-in procedures.
   c. Routine and normal operating instructions.
   d. Regulation and control procedures.
   e. Control sequences.
   f. Safety procedures.
   g. Instructions on stopping.
   h. Normal shutdown instructions.
   i. Operating procedures for emergencies.
   j. Operating procedures for system, subsystem, or equipment failure.
   k. Seasonal and weekend operating instructions.
   l. Required sequences for electric or electronic systems.
   m. Procedures and recordings for operating equipment above Wood Ceilings and all ceilings besides 2’x2’ ACT ceilings.
n. Special operating instructions and procedures.
5. Adjustments: Include the following:
   a. Alignments.
   b. Checking adjustments.
   c. Noise and vibration adjustments.
   d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
   a. Diagnostic instructions.
   b. Test and inspection procedures.
7. Maintenance: Include the following:
   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Procedures and recordings for accessing equipment above Wood Ceilings and all ceilings besides 2’x2’ ACT ceilings.
   h. Instruction on use of special tools.
8. Repairs: Include the following:
   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

PART 3 EXECUTION

3.1 PREPARATION
A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with operation and maintenance data.
B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION
A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
B. Engage qualified instructors to instruct Owner’s personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
   1. Owner will furnish Contractor with names and positions of participants.
C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
   1. Schedule training with Owner, with at least ten business days' advance notice.
D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
E. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
   1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video: Provide minimum 640 x 480 video resolution converted to format file type acceptable to Owner, on electronic media.
   1. Electronic Media: Read-only format acceptable to Owner, with commercial-grade graphic label.
   2. File Hierarchy: Organize folder structure and file locations according to project manual table of contents. Provide complete screen-based menu.
   3. File Names: Utilize file names based upon name of equipment generally described in video segment, as identified in Project specifications.
   4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training Video that describes the following for each Contractor involved on the Project, arranged according to Project table of contents:
      a. Name of Contractor/Installer.
      b. Business address.
      c. Business phone number.
      d. Point of contact.
      e. E-mail address.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
   1. Film training session(s) in segments not to exceed 30 minutes.
      a. Produce segments to present a single significant piece of equipment per segment.
      b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
      c. Where a training session on a particular piece of equipment exceeds 30 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.

END OF SECTION
SECTION 01 81 23
ACOUSTIC ISOLATION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies common requirements for acoustic isolation construction throughout the project.

B. The construction enclosing a significant proportion of the building spaces on the project is designed to achieve high degrees of acoustic isolation that are critical to the successful functioning of the completed project. The acoustic isolation construction encompasses multiple disciplines, trades, and contractors. Careful coordination among the entities involved, vigilant adherence to specialized details, and a high level of installation precision are required for proper implementation of the acoustic isolation construction.

C. The acoustic isolation requirements specified in this section are applicable to the following spaces:

1. Trap Room 0240
2. Orchestra Pit 0235
3. Valade Jazz Center 1110
4. Green Room 1113
5. AV Rack Room 1116
6. Audience Chamber 1230
7. Stagehouse 1240
8. Studio Theater 1227
9. Dressing Room 2123
10. Dressing Room 2122
11. Control Room 2223
12. Audio Rack Room 2231
13. Dimmer Room 2230
14. Followspot 3200
15. Mechanical and Electrical Equipment Spaces
16. Sound and Light Locks (SLL)

1.2 RELATED SECTIONS

A. Related sections include:

1. 03 3000 Cast-in-Place Concrete
2. 04 2200 Concrete Unit Masonry
3. 05 4000 Cold-Formed Metal Framing
4. 07 2100 Thermal Insulation
5. 07 8413 Penetration Firestopping
6. 07 8446 Fire-Resistive Joint Firestopping
7. 07 9200 Joint Sealants
8. 08 1113 Hollow Metal Doors and Frames
9. 08 5673 Sound Control Window Assemblies
10. 09 2900 Gypsum Board Assemblies
PART 2 - PRODUCTS (refer to Related Sections for product specifications)

PART 3 - EXECUTION

3.1 PRE-INSTALLATION CONFERENCE

A. A pre-installation conference shall be convened prior to installation of any interior acoustic isolation construction. Attendees shall include the contractor, architect, acoustic consultant, and subcontractors, fabricators, and installers of work in the spaces covered by this specification. At a minimum, trades represented shall include masonry, carpentry, specialty interior finishes, doors, mechanical, electrical, and plumbing. Contractor representatives shall include on-site superintendents.

B. The agenda for the pre-installation conference shall include review of the acoustic isolation requirements specified in this section and elsewhere in the contract documents; comprehension of the contract documents and design intent; specific construction details and assemblies; means and methods; sequencing, tolerances, and required clearances; coordination of the work by multiple entities; and possible conflicts and incompatibilities.

3.2 REQUIREMENTS FOR AIRTIGHT ACOUSTIC ISOLATION CONSTRUCTION

A. The physical envelopes of all spaces covered by this section of the specifications shall be constructed "airtight", i.e. leak-proof for the purposes of acoustic isolation.

B. Airtightness shall be maintained at all walls, ceilings, floors, doors, and windows, and their intersection with adjacent construction; construction joints; penetrations by structural elements, mechanical ducts, pipes, electrical conduits, and other infrastructure items; and at electrical boxes and fixtures, cabinets, access panels, windows, frames, and supports.

C. All electrical, lighting, or other recessed boxes 4"x4" and smaller, installed within spaces covered by this section of the specifications, shall be caulked at their interface with gypsum board finish, and shall be covered on the back sides with putty pads. All electrical, lighting, or other recessed boxes larger than 4"x4" shall be caulked at their interface with gypsum board finish and provided with one (1) layer of 5/8" gypsum board on the back sides, with all joints sealed.

D. Every precaution shall be taken to maintain airtight construction around the physical envelopes of all spaces covered by this section of the specifications, whether explicitly indicated in the contract documents or not. Provide additional framing, blocking, escutcheons, grouting, gaskets, packing, caulking, putties, taping, filling, and / or other elements as required to achieve airtight construction.

3.3 INSPECTION OF WORK

A. The architect and acoustic consultant will make periodic visits to the site to inspect progress of the work. Contractor shall notify the architect and acoustic consultant in advance of when the following check points have been made in spaces covered by this specification, and that the conditions are available for inspection:

1. Completion of wall and ceiling framing; plumbing, mechanical, and electrical systems; prior to installation of insulation or gypsum board.

ACOUSTIC ISOLATION REQUIREMENTS 01 81 23 - 2
B. If work to be inspected is covered up prior to architect and acoustic consultant’s approval of the above checkpoints, the materials shall be removed so such inspections can occur.

C. Any work deemed unacceptable shall be remedied but not covered up until re-inspected.

END OF SECTION
SECTION 018198
FACILITY ACOUSTIC PERFORMANCE REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Special acoustical performance requirements of Project.
   1. Definition and identification of acoustically-critical spaces.
   2. Qualifications requirements.
   3. Preconstruction conference.
   5. Repair of work not in compliance with specified requirements.
B. Related Work: Coordinate with Work of other specification sections related to Work of this Section and acoustically-critical spaces and construction.
   1. Specific test and inspection requirements are not specified in this Section.
C. Related Sections:
   1. Section 033000 - Cast-in-Place Concrete: Isolated concrete deck and isolation pads and coordination of underlayment installation.
   2. Section 054000 - Cold-Formed Metal Framing, Section 092200 - Non-Structural Metal Framing and Section 092900 - Gypsum Board: Stud-framed gypsum board assemblies incorporating resilient hangers and isolators.
   3. Section 057000 - Ornamental Metal: Metal panels and screens within performance space.
   5. Section 077236 - Smoke Vents: STC-rated smoke vents.
   7. Section 083100 - Access Panels: STC-rated access panels.
   8. Section 083473 - Sound Control Door Assemblies.
   9. Section 085673 - Sound Control Window Units.
   10. Section 087100 - Door Hardware: Sound gasketing.
   11. Section 088000 - Glazing: STC-rated glass units.
   13. Section 095100 - Acoustic Ceiling Tile.
   14. Section 098400 - Acoustic Surface Treatments: Sound-absorbing, [reflecting] [and] [diffusing] panels, assemblies and surface treatments for walls and ceilings.
   15. Section 134833 - Sound and Vibration Control: Manufactured sound and vibration control products.
   16. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment
   17. Section 230548 - Vibration Controls for HVAC

1.2 REFERENCES
A. Acoustician's Report.

1.3 DEFINITIONS
A. Acoustically-Critical Spaces: The following spaces are acoustically-critical spaces, requiring special provisions and restrictions to meet the target background noise levels, achieve proper sound isolating performance of demising constructions, and achieve the design intent for interior acoustic performance:
   1. Proscenium Theater
2. Valade Theater  
3. Audience Chamber  
4. Stagehouse  
5. Studio Theater  
6. Sound & Light Locks  
7. Trap Room  
8. Control Booths  
9. Projection Booth  
10. Dimmer Room  
11. Audio Rack Room, Sound, Communications, and AV Equipment Rooms  
12. Mechanical and Electrical Rooms  

1.4 INFORMATIONAL SUBMITTALS  
A. Qualification Data: For qualified fabricators, installers, and testing agencies.  
B. Certificates: Manufacturer’s certificates for products and equipment.  
C. Test and Inspection Reports: Prepare and submit certified written reports as specified in other Sections.  
D. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor’s construction schedule. Update as the Work progresses.  

1.5 QUALITY ASSURANCE  
A. Fabricator and Manufacturer Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service acoustical performance. Qualified firm will provide authorized technical representatives to observe and inspect installation of products, equipment and assemblies.  
B. Subcontractors and Installers Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, being familiar with special acoustical requirements indicated, and whose work has resulted in construction with a record of successful acoustical performance.  
   1. Engage specialists who satisfy qualification requirements indicated in specifications.  
C. Acoustical Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.  
   1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.  
   2. NVLAP: A testing agency accredited according to NIST’s National Voluntary Laboratory Accreditation Program.  

1.6 PRECONSTRUCTION CONFERENCE  
A. Preconstruction Conference: Prior to start of Work, conduct a conference to ensure understanding of Construction Documents and special acoustical requirements of acoustically-critical spaces and construction.  
   1. Attendees: Contractor, Architect, acoustic consultant, theater consultant, audio/visual consultant, subcontractors, fabricators and installers of Work in acoustically-critical spaces. At minimum, sub-contractors represented shall include but is not limited to; carpentry, masonry, specialty interior finish, door, mechanical, electrical and plumbing.  
   2. Agenda: Include the following agenda items:
a. Acoustical performance requirements of completed project.
b. Comprehension of Contract Documents and design intent.
c. Construction details and assemblies.
d. Review qualifications of personnel assigned to the work.
e. Review installation, sequencing, tolerances and required clearances.
f. Coordination of work by multiple subcontractors.
g. Possible conflicts and compatibility issues. Possible performance issues.
h. Possible bridging of vibration isolation joints or flanking of airborne sound.
i. Building services equipment and installation methods.
j. Applicable field conditions, field dimensions, means and methods, general guidelines and practices.
k. Other discussion topics and considerations related to acoustically-critical spaces and construction.
l. Coordinate sleeving and sealing of penetrations through partitions and slabs at acoustically-critical spaces and at mechanical and electrical rooms.

PART 2 PRODUCTS

2.1 PRODUCTS

A. Refer to specifications for product requirements.

B. Provide products identical to those tested by an acoustical testing agency.

PART 3 EXECUTION

3.1 EXECUTION OF ACOUSTICALLY-CRITICAL WORK

A. Refer to applicable specification sections for specific requirements.

B. Do not enclose or obscure items requiring testing and inspection services after placement until after testing and inspection services are performed.

C. Coordinate and provide sleeving and sealing of penetrations through partitions and slabs at acoustically-critical spaces and at mechanical and electrical rooms.
   1. Duct, pipe and conduit penetrations at acoustically-critical spaces shall be sleeved, packed and sealed airtight with flexible non-hardening sealant.
   2. Provide 1-inch flexible joint around penetrating elements, unless otherwise indicated in the Construction Documents.

D. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

E. Not Permitted in Installed Work: Vibration harmonics; noises caused by movement of components; vibration transmitted to other building elements; loosening, weakening, or fracturing of attachments or components of system.

3.2 TESTING AND INSPECTING

A. Acoustical Testing and Related Inspections: Engage qualified testing agency as indicated in individual Specification Sections, and perform additional inspections required to verify that the Work complies with requirements, whether specified or not.
   1. Provide advanced notice of at least five (5) working days to Owner, Architect and acoustic consultant to schedule field-testing and site inspections.
2. Interpret tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
3. Notify Architect promptly of irregularities and deficiencies observed in the Work during performance of its services.
4. Retest and re-inspect corrected work.
5. Submit a final report of acoustical tests and inspections at Substantial Completion. Include descriptions of unresolved deficiencies.

B. Scheduling and Coordination: Inspection of installation and workmanship may occur prior to or during completion of the Work, including:
   1. After completion of all partition framing, the first course of masonry work, ceiling framing, rough door framing, window framing, resilient ceiling hangers and sway braces, but before installation of the drywall, plaster or any other interior finish for all acoustically-critical Spaces.
   2. After installation of acoustic underlayment or slab isolation, but prior to finish flooring installation.
   3. After all partitions, doors, windows, ceilings and floors, ductwork, conduit, sprinklers, have been installed and completed, including acoustic sealing of partition, ceiling and floor penetrations, but prior to installation of interior wall, ceiling or floor finishes in acoustically-critical spaces.
   4. Acoustical inspection of all other construction shall occur as appropriate to the phase and level of completion of each part of the work.

C. Preparation for Inspections:
   1. Confirm the air distribution system is fully balanced and operating normally.
   2. Identify construction and equipment within acoustically-critical spaces

D. Prior to final commissioning by Acoustic Consultant, inspect and perform acoustical testing to determine compliance with requirements, including:
   1. Overall separation of acoustically-critical spaces, acoustic sealant joints, vibration and airborne sound control.
   2. Installation and adjustment of acoustically-rated doors, door sets, gasketing and hardware.
   3. Installation and adjustment of sound-control door and frame assemblies.
   4. Installation and operation of sound-control window units.
   5. Sealing of service penetrations into and out of acoustically-critical spaces.
   6. Installation and operation of fixed and adjustable acoustic surface treatments and room tuning products and assemblies.
   7. Installation of sound and vibration components, vibration isolation joints and resilient equipment mounting and attachment.

3.3 REPORT
A. Acoustic inspector will prepare a punchlist to itemize observed conditions that are not in compliance with specified requirements or intent of the Construction Documents.
B. Do not proceed until the Architect and Acoustic Consultant have reviewed and approved these constructions in the field with the appropriate Contractor representative.

3.4 CORRECTION OF WORK
A. Perform corrective measures in a timely manner acceptable to the Owner and prior to proceeding with subsequent work related Work.
B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

END OF SECTION
SECTION 01 91 13
COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the contract, including General and Supplementary
      Conditions and other Division 01 specification sections, apply to this section.
   B. Owner’s Project Requirements and Basis of Design documents are included by reference for
      information only.
   C. Related Sections include the following:
      Division 01 Section “Coordination.”
      Division 01 Section “Construction Progress Documentation.”
      Division 01 Section “Submittal Procedures.”
      Division 01 Section “LEED Requirements.”
      Division 01 Section “Closeout Procedures” for Project Records, Operation and Maintenance
      Manuals.

1.2 SUMMARY
   A. This section includes general requirements that apply to the implementation of the
      commissioning process without regard to specific systems, assemblies, and components.

1.3 DEFINITIONS
   A. Acceptance: A formal action, taken by a person with appropriate provider (which may or may
      not be contractually defined) to declare that some aspect of the project meets defined
      requirements, thus permitting subsequent activities to proceed.
   B. Approval: Acceptance that a piece of equipment or system has been properly installed and is
      functioning in the tested modes according to the Contract Documents.
   C. Basis of Design (BoD): A document that records the concepts, calculations, decisions, and
      product selections used to meet the Owner’s project requirements and to satisfy applicable
      regulatory requirements, standards, and guidelines. The document includes both narrative
      descriptions and lists of individual items that support the design process.
   D. Checklists: Verification checklists that are developed and used during all phases of the
      commissioning process to verify that the Owner’s project requirements are being achieved. This
      includes checklists for general verification, plus testing, training, and other specific
      requirements.
   E. Commissioning Authority (CxA): The entity identified by the Owner who leads, plans,
      schedules, and coordinates the commissioning team to implement the commissioning process.
   F. Commissioning Plan: An overall plan developed by the commissioning agent that provides the
      structure, schedule and coordination planning for the commissioning process.
G. Commissioning Process: A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner’s project requirements.

H. Commissioning Process Activities: Components of the commissioning process.

I. Commissioning Process Progress Report: A written document that details activities completed as part of the commissioning process and significant findings from those activities that is continuously updated during the course of a project. Usually it is incorporated into the commissioning plan as an ongoing appendix.

J. Commissioning Team: The individuals who through coordinated actions are responsible for implementing the commissioning process.

K. Construction Checklist: A form used by the Contractor to verify that appropriate components are on-site, ready for installation, correctly installed, and functional. Also refer to Checklists.

L. Construction Documents: This includes a wide range of documents, which will vary from project to project, with the Owner’s needs and with regulations, laws, and countries. Construction documents usually include the Project Manual ( specifications), plans (Drawings) and general terms and conditions of the Contract.

M. Continuous Commissioning Process: A continuation of the commissioning process well into the occupancy and operations phase to verify that a project continues to meet current and evolving Owner’s project requirements. Continuous commissioning process activities are on-going for the life of the facility. Also refer to On-Going Commissioning Process.

N. Contract Documents: This includes a wide range of documents, which will vary from project to project, with the Owner’s needs and with regulations, laws, and countries. Contract Documents frequently include price agreements, construction management process, sub-contractor agreements or requirements, requirements and procedures for submittals, changes, and other construction requirements, timeline for completion, and the construction documents.

O. Coordination Drawings: Drawings showing the work of all trades to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers’ recommended maintenance clearances.

P. Control System: A component of environmental, HVAC, security, and fire systems for reporting/monitoring and issuing of commands to/from field devices.

Q. Data Logging: The monitoring and recording of flows, currents, status, pressures, etc., of equipment using stand-alone data recorders separate from the control system or the trending capabilities of control systems.

R. Deferred Performance Tests (DPTs): Performance tests that are performed, at the discretion of the CxA, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design, or other site conditions that disallow the test from being performed.

S. Deficiency: A condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the Contract Documents.

T. Field Quality Control: Testing of equipment on-site, by factory personnel, or by the Contractor with or without the assistance of factory personnel, and with or without an Owner’s representative present.
**U. Issues Log:** A formal and ongoing record of problems or concerns, and their resolutions, which have been raised by members of the commissioning team during the course of the commissioning process.

**V. Non-Compliance:** See Deficiency.

**W. Non-Conformance:** See Deficiency.

**X. Owner’s Project Requirements (OPR):** A written document that details the functional requirements of a project and the expectations of how it will be used and operated. This includes project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. (The term “Project Intent” is used by some Owners for their commissioning process Owner’s project requirements or design.)

**Y. Over-ridden Value:** Riding over a sensor value in the equipment’s controls to observe the response of the equipment’s operation. Also see **Simulated Signal**.

**Z. Phased Commissioning:** Commissioning that is completed in phases as required by the phasing plan for the project and other scheduling issues.

**AA. Quality Based Sampling:** A process for evaluating a sub-set (sample) of the total population. The sample is based upon a known or estimated probability distribution of expected values; an assumed statistical distribution based upon data from a similar product, assembly, or system; or a random sampling that has scientific statistical basis.

**BB. Re-Commissioning:** An application of the commissioning process requirements to a project that has been delivered using the commissioning process. This may be a scheduled re-commissioning developed as part of an ongoing commissioning process, or it may be triggered by use change, operations problems, or other needs.

**CC. Retro-Commissioning:** The commissioning process applied to an existing facility that was not previously commissioned. This guideline does not specifically address retro-commissioning. However, the same basic process needs to be followed from pre-design through occupancy and operations to optimize the benefits of implementing the commissioning process philosophy and practice.

**DD. Seasonal Performance Tests:** Performance tests that are deferred until the system(s) will experience conditions closer to their design conditions based on weather conditions.

**EE. Simulated Condition:** Condition that is created for the purpose of testing the response of a system (e.g., raising/lowering the setpoint of a thermostat to see the response in a VAV box).

**FF. Simulated Signal:** Disconnecting a sensor and using a signal generator to simulate a sensor value for the purpose of testing a full range of conditions.

**GG. Source Quality Control:** Testing of equipment at the factory, by factory personnel, with or without an Owner’s representative present.

**HH. Startup:** The initial starting or activating of dynamic equipment, including completing construction checklists.

**II. Systems Manual:** A system-focused composite document that includes the operation manual, maintenance manual, and additional information of use to the Owner during the occupancy and operations phase.
JJ. Test Procedure: A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems. The test procedures are specified in the Technical Specifications sections of the Contract Documents. Performance testing covers the dynamic functions and operations of equipment and systems using manual or monitoring methods. Performance testing is the dynamic testing of systems under full operation. Systems are tested under various modes, such as during low cooling loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system’s sequences of operation and components are verified to respond as the sequences state.

KK. Training Plan: A written document that details the expectations, schedule, budget, and deliverables of commissioning process activities related to training of project operating and maintenance personnel, users, and occupants.

LL. Verification: The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Owner’s Project Requirements.

MM. Trending: The monitoring, by a building automation system (BAS) or other electronic data gathering equipment and analyzing of the data gathered over a period of time.

NN. Vendor: Supplier of equipment.

OO. Warranty Period: Refer to the Conditions of the Contract and individual Specification Sections.

1.4 DESCRIPTION

A. Commissioning: Commissioning is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet defined objectives and criteria. The Commissioning process begins at project inception (during the pre-design phase) and continues through the life of the facility. The commissioning process includes specific tasks to be conducted during each phase in order to verify that design, construction, and training meets the Owner's project requirements.

B. Commissioning Team: The members of the commissioning team consist of the contracted commissioning authority (CxA), Building Enclosure Commissioning Authority (BECxA), the Owner’s Representative/Construction Manager (CM), the General Contractor (GC), the Architect and Engineers (A/E), the mechanical subcontractor (MC), the electrical subcontractor (EC), the testing and balancing (TAB) subcontractor, the control subcontractor (CC), the facility operating staff, and any other installing subcontractors or suppliers of equipment. The CxA is hired by the Owner directly. The CxA directs and coordinates the project commissioning activities and the reports to the Owner. All team members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.

C. Commissioning shall:

Verify that applicable equipment and systems are installed according to the Contract Documents, manufacturer’s recommendations, and industry accepted minimum standards and that they receive adequate operational checkout by installing Contractors.

Verify that the building cladding, fenestration, and roofing systems are designed and installed to perform according to the design intent and Owner’s project requirements.

Verify the proper installation of building enclosure components and assemblies.

Verify and document proper operation of equipment and systems.
Verify that O&M documentation left on site is complete.
Verify that the Owner’s operating personnel are adequately trained.

D. The commissioning process does not take away from or reduce the responsibility of the system designers or installing Contractors to provide a finished and fully functioning product.

1.5 SUBMITTALS

A. The CxA will provide appropriate Contractors with a specific request for the type of submittal documentation the CxA requires facilitating the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer’s printed installation and detailed startup procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of Owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA. All documentation requested by the CxA will be included by the subcontractors in their O&M manual contributions.

B. The CxA will review submittals related to the commissioned equipment and specific building enclosure components for conformance to the Contract Documents as it relates to the commissioning process, to the performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of performance procedures and only secondarily to verify compliance with equipment specifications. The commissioning authority will notify the Owner/CM, PM or A/E as requested, of items missing or areas that are not in conformance with Contract Documents and may require resubmission.

C. The CxA may request additional design narrative from the A/E and controls subcontractor, depending on the completeness of the OPR documentation and sequences provided with the Specifications.

D. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the CxA will review them.

1.6 REFERENCED STANDARDS

A. ASHRAE Guideline 0 “The Commissioning Process”


C. ASTM E2813 “Standard Practice for Building Enclosure Commissioning”

1.7 QUALITY ASSURANCE

A. ASHRAE: Follow Guidelines:


B. InterNational Electrical Testing Association: NETA Acceptance Testing Specifications (ATS) - 1996
C. Instructor Qualifications: Factory-authorized service representatives, experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.

D. Test Equipment Calibration: Comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments or have certificates readily available. Instruments shall have been calibrated within six months prior to use.

1.8 COORDINATION

A. Project Commissioning Team: The members of the project commissioning team will consist of the commissioning authority and any support personnel, the Construction Manager, the Owner's facility staff (FS) or designee, the General Contractor, subcontractors and/or vendors as required, and the Architect/Engineer (A/E).

B. Management: The CxA coordinates the commissioning activities through the Construction Manager. All members shall work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents. Refer to Article "Commissioning Plan" for additional management details.

C. Scheduling: The CxA, through the Owner or CM, will provide sufficient notice to the Contractor for scheduling commissioning activities with respect to the Owner's participation. The Contractor will integrate all commissioning activities into the overall project schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

D. Manufacturers' Field Services: CxA shall coordinate through the CM the services of manufacturers' field representatives to demonstrate the operation of packaged controlled equipment.

1.9 COMMISSIONING PLAN

A. The CxA will develop the commissioning plan which shall be included in the project schedule after review by the Owner or CM. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.

Commissioning during construction begins with an initial commissioning meeting conducted by the CxA where the commissioning process is reviewed with the project commissioning team members.

Additional meetings will be required throughout construction, scheduled by the CxA, through the Owner or CM, with necessary parties attending to plan, scope, coordinate, schedule future activities and resolve problems.

Equipment documentation is submitted to the CxA, through the Owner or CM, during normal submittals, including detailed startup procedures.

The construction checklists are to be completed by the Contractor (or subcontractors), before and during the startup process.

Construction checklists, TAB and startup must be completed before performance testing.

Items of non-compliance in material, installation, or setup shall be corrected at no expense to the Owner.
The Contractor ensures that the subcontractors’ construction checklists are executed and documented, and that startup and initial checkout are performed. The CxA verifies that the TAB, construction checklists and startup were completed according to the plans. This includes the CxA reviewing TAB, checklists and startup plans. This may also include the witnessing of startup of selected equipment. Any testing failure is to be corrected at no additional cost to the Owner, and a re-test is to be performed, observed, and documented.

The CxA develops and implements equipment, system, and building components performance test procedures. The forms and procedures are reviewed by the Owner, CM and A/E.

The performance tests are executed by the Contractor under the direction of the CxA with the assistance of the facility staff, or third-party testing agency. All documentation is by the CxA.

The CxA reviews the O&M documentation for completeness and provides the commissioning record for the O&M manuals.

Commissioning should be completed before substantial completion.

The CxA reviews the Contractors training plan and ensures that training of the Owner’s Facility personnel is provided by the Contractor.

Deferred testing is conducted as specified or required.

1.10 COMMISSIONING TEAM

A. Members appointed by Contractor(s): Individuals, each having authority to act on behalf of the entity they represent, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members appointed by Owner:

CxA - An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.

Representatives of the facility user and operation and maintenance personnel.

Architect and engineering design professionals.

1.11 RESPONSIBILITIES

A. The general responsibilities of various parties in the commissioning process are provided in this Article. The specific responsibilities are in the Technical Specifications.

B. All Parties:

Follow the commissioning plan.

Attend initial commissioning meeting and additional meetings as necessary.

C. Architect (of A/E):

Construction Phase:
Prepare BoD documents for review and distribution by the Owner.

Attend the commissioning scoping meeting and selected commissioning team meetings.

Perform normal submittal review, construction observation, as-built drawing preparation, project punch list preparation, etc., as contracted.

Provide any design narrative documentation requested by the CxA.

Coordinate resolution of system deficiencies identified during commissioning, according to the Contract Documents.

Prepare and submit final as-built design intent documentation for inclusion in the O&M manuals. Review the O&M manuals.

D. Mechanical and Electrical Designers/Engineers (of the A/E):

Construction Phase:

Perform normal submittal review, construction observation, as-built drawing preparation, project punch list preparation, etc., as contracted. One site observation should be completed just prior to system startup.

Provide any design narrative and sequences documentation requested by the CxA. The designers shall assist (along with the Contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

Attend commissioning scoping meetings and other selected commissioning team meetings.

Participate in the resolution of system deficiencies identified during commissioning, according to the Contract Documents.

Prepare and submit the final as-built design intent and operating parameters documentation for inclusion in the O&M manuals. Review the O&M manuals.

Occupancy and Operations Phase:

Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning.

E. Commissioning Authority (CxA):

The Contractors will provide all tools or the use of tools to start, check-out and test equipment and systems, except for specified testing with portable data-loggers, which shall be supplied and installed by the CxA when necessary.

The CxA will verify the execution of commissioning process activities using random sampling as coordinated with the Owner. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, CxA will report the failure in the "Issues Log."

Construction Phase:
Coordinates and directs the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.

Coordinate the commissioning work and, with the Owner/CM, help integrate commissioning activities into the master schedule.

Revise the Construction Phase Commissioning Plan as necessary.

Plan and conduct a commissioning scoping meeting and other commissioning meetings.

Request and review additional information required to perform commissioning tasks, including O&M materials, Contractor startup and checkout procedures.

Before startup, gather and review the current control sequences and interlocks and work with Contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.

Review normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs.

Write and distribute construction checklists. Prepare and maintain completed construction checklist log.

Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.

Review construction checklist completion by selected site observation and spot checking.

Recommend approval of systems startup by reviewing startup reports and by selected site observation.

Analyze any performance trend logs and monitoring data to verify performance when necessary.

Coordinate and witness manual performance tests performed by installing Contractors.

Maintain a master Issues Log and a separate testing record. Provide the Owner/CM with written progress reports and test results.

Witness performance testing of smoke control systems by Authority Having Jurisdiction and all other Owner contracted tests or tests by manufacturer's personnel over which the CxA may not have direct control. Document these tests and include this documentation in Commissioning Record.

Witness part of the building enclosure systems installation. Document observations, notify Owner/CM of any deficiencies in procedures.

Witness performance testing of window assemblies, and installation testing of wall and roof components.

Ensure the training of the Owner’s operating personnel.
Compile and maintain a commissioning record, Cloud-Based database or hard copy book(s).

Review the O&M manuals for compliance with the Contract requirements.

Provide a final commissioning report (as described in this Section).

Occupancy and Operations Phase:

Coordinate and supervise required seasonal or deferred testing and deficiency corrections if needed.

F. Owner or Owner’s Representative (CM):

Establish Contracts:

Owner and Architect: Agreement for design.

Owner and Contractor: Contract for construction.

Owner and Commissioning Authority: Agreement for observation and review of the commissioning process.

Construction and Acceptance Phase:

Facilitate the coordination of the commissioning work by the CxA, and, with the GC and CxA, ensure that commissioning activities are being scheduled into the master schedule.

Provide utility services required for the commissioning process.

Review the final "Commissioning Plan - Construction Phase."

Attend a commissioning scoping meeting and other commissioning team meetings.

Perform the normal review of Contractor submittals.

Furnish a copy of all construction documents, addenda, change orders and reviewed submittals and shop drawings related to commissioned equipment to the CxA.

Review the performance test procedures submitted by the CxA, prior to testing.

When necessary, observe and witness startup and performance testing of selected equipment.

Review commissioning progress and deficiency reports.

Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.

Assist in coordinating the training of Owner personnel.

Provide the OPR documentation to the CxA and each Contractor for information and use.

Provide the BoD documents, prepared by Architect and reviewed by Owner, to the CxA and each Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
Occupancy and Operations Phase:

Assist the CxA as necessary in the seasonal or deferred testing and deficiency corrections required by the Specifications.

G. Owner’s Project Manager (PM):

Construction Phase:

Manage the Contract of the A/E and of the GC.

Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions.

Occupancy and Operations Phase:

Ensure that any seasonal or deferred testing and any deficiency issues are addressed.

H. Contractor: Each Contractor and their subcontractors and vendors shall assign representatives with expertise and authority to act on their behalf and schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

Construction Phase:

Facilitate the coordination of the commissioning and incorporate commissioning activities (the Commissioning Plan) into the Overall Project Schedule (OPS).

Integrate and coordinate commissioning process activities with the OPS.

Provide detailed startup procedures.

Provide utility services required for the commissioning process.

Include the cost of commissioning in the total Contract price.

Ensure that all subcontractors and vendors execute their commissioning responsibilities according to the Contract Documents and the OPS.

Provide copies of all submittals as required in Division 01 Section "Submittals" including all changes thereto. Attend and participate in commissioning team meetings.

No later than 60 days prior to startup of the first piece of major equipment, meet with the CxA, CM, A/E, and PM and Owner to finalize the detailed commissioning procedures/ schedule.

Provide the training of Owner personnel.

Review construction checklists provided by the commissioning authority.

Complete construction checklists as work is completed and provide to the CxA.

Accomplish commissioning process test procedures.

Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.

Cooperate with the CxA for resolution of issues recorded in the “Issues Log”.

Permit Set

29 June 2020
Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built/as-tested conditions.

Occupancy and Operations Phase:

Ensure that subcontractors provide assistance for seasonal or deferred performance testing, performed by the CxA, according to the Specifications.

Ensure that subcontractors correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

Perform all guarantee work for materials furnished under the contract for the time specified in the Contract, including all warranties and curing all latent defects within the time period provided in the Contract.

I. Vendors/Subcontractors:

Provide all requested submittal data, including detailed startup procedures and specific responsibilities of the Owner to keep warranties in force.

Assist in equipment testing per agreements with subcontractors and/or Contractor.

Include cost of all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing, operating, and maintaining equipment according to these Contract Documents in the base bid price to the Contractor.

Analyze specified products and verify that the A/E has specified the newest, most current equipment reasonable for this project’s scope and budget.

Provide requested information regarding equipment sequence of operation and testing procedures.

Review construction checklists and test procedures for equipment installed by factory representatives.

1.12 EQUIPMENT/SYSTEMS TO BE COMMISSIONED

A. The following equipment/systems will be commissioned in this project:

Mechanical Systems:

a. Heating systems.
   1) Heating Hot Water System
   2) Associated pumps and controls
   3) Humidification Systems.

b. Cooling systems.
   1) Air Cooled Chilled Water System.
   2) Associated pumps, heat exchanger and controls.

c. Air handling systems.
   1) Blower Coil units.
2) Air Handling Systems.

d. Terminal systems.
   1) Air Terminal Units.
   2) Terminal Heating Devices (Unit heaters, Cabinet Unit Heaters & Radiant Heaters)

e. Exhaust and stand-alone systems.
   1) Ductless split systems Air Conditioning Systems.
   2) Exhaust and Ventilation Fans.
   3) Lab Exhaust, Dust Collector and Welding Exhaust Fans.

f. Plumbing systems:
   1) Domestic Water Heaters and circulation pump.
   2) Compressed Air System.
   3) Sump Pumps.

Electrical systems:

  g. Lighting Systems.
     1) Interior Lighting Controls
     2) Site Lighting.

Building Envelope:

  h. Building Envelope Systems and Assemblies
     1) Building Roof.
     2) Building Walls.
     3) Building Windows.

Any other systems as required to comply with LEED Version 4 Rating System, Energy and Atmosphere Prerequisite 1, Fundamental Building Systems Commissioning.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup and initial checkout and required performance testing shall be provided by the Contractor for the equipment being tested. This includes, but is not limited to, two-way radios, meters, and data recorders. Data recorders may be provided by the CxA at the option of the CxA.

B. Special equipment, tools, and instruments required for testing equipment according to these Contract Documents shall be included in the Contractor’s base bid price and shall be turned over to the Owner at Project close-out.
C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified in the specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration to NIST traceable standards to an accuracy of 0.5 deg F and a resolution of plus or minus 0.1 deg F. Pressure sensors shall have an accuracy of plus or minus 2.0 percent of the value range being measured (not full range of meter).

2.2 EQUIPMENT FOR ACCESS

A. Provide means for the CxA and their subconsultants to access, observe, touch, and visually observe installation of components. These means shall be in compliance with all OSHA and job-site safety regulations.
PART 3 - EXECUTION

3.1 MEETINGS

A. Initial Meeting: The CxA, through the Owner/CM, will schedule, plan and conduct an initial commissioning meeting. The Contractor and Contractor’s responsible parties are required to attend.

B. Miscellaneous Meetings: Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution, and planning issues. These meetings will be held at least monthly, until the final 2 months of construction, when they may be held as frequently as one per week.

3.2 STARTUP, CONSTRUCTION CHECKLISTS, AND INITIAL CHECKOUT

A. The following procedures apply to all equipment/systems to be commissioned, according to Article “Equipment/Systems to be Commissioned.”

B. General: Construction checklists are important to verify that the equipment and systems are fully connected and operational. It ensures that performance testing (in-depth system checkout) may proceed without unnecessary delays. The construction checklists for a given system must be successfully completed and approved prior to startup and formal performance testing of equipment or subsystems of the given system.

C. Startup and Checkout: The CxA may assist the project commissioning team members responsible for startup of any equipment. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures has been completed. The CxA shall provide construction checklists and startup shall be identified in the commissioning scoping meeting and on the checklist forms.

The construction checklists are provided in with the Cx Manual. These checklists indicate required procedures to be executed as part of startup and initial checkout of the systems and the party responsible for their execution.

The Contractor shall determine which trade is responsible for executing and documenting each of the line item tasks and transmit the checklists to the responsible subcontractors. Each form may have more than one trade responsible for its execution.

The Contractor/subcontractor with assistance from the CxA responsible for the purchase of the equipment shall develop the full startup plan by combining the manufacturer’s detailed startup and checkout procedures and the construction checklists.

The Contractor/subcontractor shall submit the full startup plan to the CxA for review and approval.

The Contractor will transmit the full startup plan to the subcontractors for their review and use.

D. Sensor and Actuator Calibration: All field-installed temperature, relative humidity, CO, CO2, refrigerant, O2, and/or pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated. Verify that all locations are appropriate and away from causes of erratic operation. Submit to the CxA through the CM the calibration methods and results

1. Tolerances, Standard Applications
<table>
<thead>
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<th>Sensor</th>
<th>Tolerance (+/-)</th>
<th>Sensor</th>
<th>Tolerance (+/-)</th>
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</thead>
<tbody>
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<td>Flow rates, water</td>
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<tr>
<td>AHU wet bulb or dew point</td>
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<td>Natural gas and oil flow rate</td>
<td>1% of design</td>
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<td>Steam flow rate</td>
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<td>Flow rates, air</td>
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<td>Barometric pressure</td>
<td>0.1 in. of Hg</td>
</tr>
</tbody>
</table>

E. Execution of Construction Checklists and Startup:

Four weeks prior to the scheduled startup, the Contractor shall coordinate startup and checkout with the CM, A/E, and CxA. The execution and approval of the construction checklists, startup, and checkout shall be directed and performed by the Contractor, subcontractor or vendor.

The Owner/CM, and A/E as necessary, shall observe, at minimum, the procedures for each piece of primary equipment.

The subcontractors and vendors shall execute startup and provide the CxA and A/E, through the Owner/CM, with a signed and dated copy of the completed startup and construction checklists.

Only individuals of the Contractor (technicians, engineers, tradesmen, vendors, etc.) who have direct knowledge and witnessed that a line item task on the construction checklist was actually performed shall check off that item. It is not acceptable for witnessing supervisors to fill out these forms.

F. Deficiencies, Non-Conformance, and Approval in Checklists and Startup (Master Issues Log):

The Contractor shall ensure that the subcontractors clearly list any outstanding items of the initial startup and construction checklist procedures that were not completed successfully, on an attached sheet. The form and any outstanding deficiencies shall be provided, through the Owner/CM, to the CxA within two days of test completion.

The CxA will review the report and issue either a non-compliance report or an approval form, through the CM, to the Contractor. The installing subcontractors or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, shall notify the Owner/CM as soon as outstanding items have been corrected, and resubmit an updated startup report with a Statement of Correction on the original non-compliance report.
Items left incomplete, which later cause deficiencies or delays during performance testing may result in backcharges to the Contractor. Refer to Article "Performance Testing" for details.

3.3 PHASED COMMISSIONING (IF REQUIRED)

A. The project requires TAB, startup and performance testing to be executed in phases. Phasing shall be coordinated with the Owner/CM, CxA, and A/E and be reflected in the overall project schedule and commissioning schedule by the Contractor. Final performance testing of all systems will be as required by the phasing plan. The performance testing of the “systems as a whole” will be performed before final turnover of the entire project.

3.4 PERFORMANCE TESTING

A. Requirements: The performance testing shall demonstrate that each system is operating according to the documented design intent and Contract Documents. Performance testing facilitates bringing the systems from a state of individual substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.

B. Coordination and Scheduling: The Contractor shall provide sufficient notice, regarding their completion schedule for the construction checklists and startup of all equipment and systems to allow the performance testing to be scheduled. The commissioning team shall oversee, witness, and document the performance of all equipment and systems. The CxA in association with the Contractor/subcontractors and facility staff shall execute the tests. Performance testing shall be conducted after the construction checklists, and startup has been satisfactorily completed. The control system shall be sufficiently tested prior to use, to verify performance of other components or systems. The air balancing and water balancing shall be completed before performance testing of air or water related equipment or systems. Testing proceeds from components to sub-systems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems shall be checked.

C. Development of Test Procedures: Before test procedures are finalized, the Contractor shall provide to the A/E and the CxA all requested documentation and a current list of changes affecting equipment or systems, including an updated points list, program code, control sequences, and testing parameters. Using the testing parameters and requirements in the technical Specifications, the CxA shall update/develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Contractor/subcontractor or vendor, as appropriate, shall provide assistance to the CxA in developing the final procedures. Prior to finalization, the A/E shall review and concur with the test procedure.

D. Test Methods:

1. Equipment/Systems

Performance testing and verification may be achieved by manual testing or by monitoring the performance and analyzing the results using the control system’s trend log capabilities or by stand-alone data loggers. The CxA may substitute specified methods or require an additional method to be executed other than what was specified, with the approval of the A/E and Owner/CM. The CxA will determine which method is most appropriate for tests that do not have a specified method.
Simulated Conditions: Simulating conditions shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.

Overridden Values: Overriding sensor values to simulate a condition, such as overriding the outside air temperature reading in a control system to be something other than it really is, is acceptable.

Simulated Signals: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overridden values.

Altering Setpoints: Rather than overriding sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable.

Indirect Indicators: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the test parameters, that the indirect readings through the control system represent actual conditions and responses.

Setup: Each performance test shall be performed under conditions that simulate actual conditions as closely as is practically possible. The Contractor/subcontractor(s) assisting the CxA in executing the test shall provide all necessary materials, system modifications, etc., to produce the necessary flows, pressures, temperatures, etc., necessary to execute the test according to the specified conditions. At completion of the test, the Contractor/subcontractor(s) shall return all affected equipment and systems to their normal operating settings.

2. Building Enclosure Components:

For tests specified in trade sections provide technicians and tools to perform test.

For tests specified to be performed by the Owner’s Testing Agency or the CxA schedule tests in cooperation with the tester and coordinate site access and the Work of related trades to facilitate the testing work.

When material or systems manufacturer provides testing, review their procedures and deliver copies to the CxA. Deliver test result reports to the CxA.

The following building enclosure tests are recommended:

ASTM E783 “Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors”

ASTM E1105 “Standard Test method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference”


AAMA 501.2 “Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems”
E. Test Equipment: Refer to Part 2 for test equipment requirements.

F. Problem Solving: The burden of responsibility to solve, correct, and retest malfunctions/failures is with the Contractor, with A/E approval as required.

3.5 DOCUMENTATION, NON-CONFORMANCE, AND APPROVAL OF TESTS

A. Documentation: The CxA shall witness and verify the documentation of the results of all performance tests. The CxA shall complete all documentation for performance testing.

B. Non-Conformance:

Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form or on an attached sheet.

As tests progress and a deficiency is identified, the CxA shall discuss the issue with the commissioning team, and the Contractor.

When there is no dispute concerning the deficiency and the Contractor accepts responsibility to correct it:

1) The CxA will document the deficiency and the Contractor’s responsible to correct the deficiency.

2) If the correction can be fixed in the field, once complete, CxA will re-test.

3) If the correction cannot be completed during the scheduled commissioning time, the Contractor shall reschedule the test; and the test repeated.

If there is a dispute about a deficiency, regarding whether or not it is a deficiency:

4) The dispute shall be documented on the non-compliance form with the Contractor’s response.

5) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Construction Manager.

6) The CxA documents the resolution.

7) The test plan is modified, or the Contractor corrects the deficiency and re-testing is scheduled.

Cost of repeating a performance test is the Contractor’s.

The Contractor shall submit in writing to the CM at least as often as commissioning meetings are being scheduled, the status of each outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreement and proposals for their resolutions.

The CxA retains the original non-conformance forms until the end of the project.

Retesting shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
3.6 DEFERRED TESTING

A. Unforeseen Deferred Tests: If any check or test cannot be completed due to the project completion level, required occupancy condition or other deficiency, execution of checklists and performance testing may be delayed upon approval of the CxA and CM. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.

B. Seasonal Testing: During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CxA shall coordinate this activity through the Owner/CM. Tests will be executed, documented by the CxA and deficiencies should be corrected by the appropriate Contractor/subcontractors with the CxA witnessing. Any final adjustments to the O&M manuals and as-builds due to the testing shall be made by the Contractor.

3.7 TRAINING OF OWNER PERSONNEL

A. The Contractor shall provide training coordination, scheduling of subcontractors, and ensure that training is completed. All training shall be coordinated, through the CM, with the CxA.

B. The Contractor shall ensure that each subcontractor and vendor (mechanical, plumbing, fire, electrical, specialty, etc.) shall have the following responsibilities:

Provide, to the CxA through the CM, a training plan before the planned training covering the following elements:

- Equipment.
- Intended audience.
- Location of training.
- Objectives.
- Subjects covered (description, duration of discussion, special methods, etc.).
- Duration of training on each subject.
- Instructor for each subject.
- Methods (classroom lecture, manufacturer’s quality video, site walk-through, actual operational demonstrations, written handouts, etc.).

Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment that makes up the system.

Training shall normally start with classroom sessions followed by hands-on demonstration/training on each piece of equipment.

The appropriate trade or manufacturer’s representative shall provide the instructions on each major piece of equipment. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
The controls subcontractor shall attend sessions other than the controls training, as specified, to discuss the interaction of the controls system as it relates to the equipment being discussed.

The training sessions shall follow the outline in the table of contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

Training shall include:

- Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
- A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
- Discussion of relevant health and safety issues and concerns.
- Discussion of warranties and guarantees.
- Common troubleshooting problems and solutions.
- Explanatory information included in the O&M manuals.
- Discussion of any peculiarities of equipment installation or operation.
- Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
- Hands-on training shall include startup, operation in all modes possible, including manual, shut-down, alarms, power failure and any emergency procedures, and preventative maintenance for all pieces of equipment.

The Contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls not controlled by the central control system.

3.8 OPERATIONS AND MAINTENANCE MANUALS/DATA

A. The commissioning process requires detailed O&M documentation as identified in this Section and technical Specifications.

B. Contractor shall submit draft copies (Electronic Files) of the complete operating and maintenance manual to the CM for review by the Architect/Engineer and CxA as specified in Division 1.

C. The Contractor shall compile O&M manuals for every piece of equipment and building operating or electrical system being commissioned as directed by the specification and CM.

END OF SECTION 01 9113
SECTION 024119
SELECTIVE DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Demolition and removal of selected portions of building or structure.
   2. Salvage of existing items to be reused or recycled.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse or store as directed.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
   1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.
   1. Inspect and discuss condition of construction to be selectively demolished.
   2. Review structural load limitations of existing structure.
   3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
   5. Review areas where existing construction is to remain and requires protection.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.
B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of Selective Demolition Activities: Indicate the following:
   1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted, if planned to be occupied.
   2. Interruption of utility services. Indicate how long utility services will be interrupted.
   3. Coordination for shutoff, capping, and continuation of utility services.
   4. Use of elevator and stairs.
   5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

D. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.

E. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

F. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.6 CLOSEOUT SUBMITTALS
   A. Inventory: Submit a list of items that have been removed and salvaged.

1.7 QUALITY ASSURANCE
   A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.8 FIELD CONDITIONS
   A. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
   B. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
      1. Hazardous materials will be removed by Owner before start of the Work.
      2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
   C. Storage or sale of removed items or materials on-site is not permitted.
   D. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
      1. Maintain fire-protection facilities in service during selective demolition operations.
PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
   1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

E. Survey of Existing Conditions:
   1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
   2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
   1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
   2. Arrange to shut off utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
   a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
   c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
   f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
   1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
   2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
   3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
   4. Cover and protect furniture, furnishings, and equipment that have not been removed.
   5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
   1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

5. Maintain fire watch during and for at least <Insert number> hours after flame-cutting operations.


7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

10. Dispose of demolished items and materials promptly. [Comply with requirements in Section 017419 "Construction Waste Management and Disposal."]

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Work in Historic Areas: Selective demolition may be performed only in areas of Project that are not designated as historic. In historic spaces, areas, and rooms, or on historic surfaces, the terms "demolish" or "remove" shall mean historic "removal" or "dismantling" as specified in Section 024296 "Historic Removal and Dismantling."

D. Removed and Salvaged Items:
   1. Clean salvaged items.
   2. Pack or crate items after cleaning. Identify contents of containers.
   3. Store items in a secure area until delivery to Owner.
   4. Transport items to Owner's storage area [on-site] [off-site] [designated by Owner] [indicated on Drawings].
   5. Protect items from damage during transport and storage.

E. Removed and Reinstalled Items:
   1. Clean and repair items to functional condition adequate for intended reuse.
   2. Pack or crate items after cleaning and repairing. Identify contents of containers.
   3. Protect items from damage during transport and storage.
   4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

F. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition [and cleaned] and reinstalled in their original locations after selective demolition operations are complete.
3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

D. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings. Do not use methods requiring solvent-based adhesive strippers.

E. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight.
   1. Remove existing roof membrane, flashings, coping, and roof accessories.
   2. Remove existing roofing system down to substrate.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site [and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.] [and recycle or dispose of them according to Section 017419 "Construction Waste Management and Disposal."]
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
   4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

3.8 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION
SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Division 00 - Procurement and Contracting Requirements, and Division 01 - General Requirements, are hereby made part of this Section.

1.02 SECTION INCLUDES

A. Interior slabs on grade.
B. Foundations, piers and walls.
C. Underslab vapor retarder.

1.03 REFERENCES

A. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete; American Concrete Institute International; 1998 (Reapproved 2004).
B. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2005.
C. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International.
D. ACI 305R - Hot Weather Concreting; American Concrete Institute International.
E. ACI 306R - Cold Weather Concreting; American Concrete Institute International.
F. ACI 309R - Guide for Consolidation of Concrete.
G. ACI 318 - Building Code Requirements for Reinforced Concrete and Commentary; American Concrete Institute International.
H. ASTM A 185/A 185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
I. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
J. ASTM A 767/A 767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
K. ASTM A 775/A 775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
S. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
X. ASTM E 1155 - Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers.
Y. ASTM E 1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
Z. COE CRD-C 513 - COE Specifications for Rubber Waterstops; Corps of Engineers.
AA. COE CRD-C 572 - COE Specifications for Polyvinylchloride Waterstop; Corps of Engineers.
AB. CRSI Manual of Standard Practice; Concrete Reinforcing Steel Institute (CRSI).

1.04 SUBMITTALS

A. See Section 01 3323 - Shop Drawings, Product Data, and Samples, for submittal procedures.
B. Product Data: Submit data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, joint systems, and others as requested by Architect.
   1. Submit data for form liners, form ties, and accessories for architectural concrete.
C. Shop Drawings: Reinforcement: Submit shop drawing prepared by a registered Professional Engineer for fabrication, bending, and placement of concrete reinforcement.
   1. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement. Include special reinforcement required and openings through concrete structures.
D. Laboratory Test Reports: Submit laboratory test reports for concrete materials and mix design test as specified.
   1. Submit proposed design mix for each type of concrete required. Per ACI 301, supplier is responsible for compatibility of admixtures.
   2. Integral Waterproofing Admixture:
      a. Permeability: Test reports indicating treated samples pressure tested to a 350 foot head of water (150 psi) showing no measurable leakage per COE CRD-C48-70 "Standard Test Method for Water Permeability of Concrete".
      b. Photographs: Evidencing use of admixture taken with a Scanning Electron Microscope (SEM) showing crystalline formations within concrete.

1.05 QUALITY ASSURANCE

A. Workmanship: Contractor is responsible for correction of concrete work which does not conform to specified requirements, including strength, tolerances and finishes. Correct deficient concrete as directed by Architect.
B. Concrete Testing Service: Employ, at Contractor's expense, a testing laboratory acceptable to the Architect to perform material evaluation tests and to design concrete mixes.
   1. Materials and installed work may require testing and retesting, as directed by Architect, at anytime during progress of work. Allow free access to material stockpiles and facilities. Tests, not specifically indicated to be done at Owner's expense, including retesting or rejected materials and installed work, shall be done at Contractor's expense.
   2. General Contractor will employ a testing laboratory for field quality control.

C. Testing Agency Personnel: Certified per ACI CP-1, as ACI Concrete Field Testing Technician, Grade 1.

D. Tests for Concrete Materials:
   1. For normal weight concrete, test aggregates per ASTM C 33.
   2. For portland cement, sample cement and determine chemical and physical properties per ASTM C 150.
   3. Submit written reports to Architect for each material sampled, and tested prior to start of work.
      a. Provide the project identification name and number, date of report, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufacturing materials, values specified in the referenced specification for each material and test results.
      b. Indicate whether or not material is acceptable for intended use.
   4. Certificates of material properties and compliance with specified requirements may be submitted in lieu of testing, when acceptable to Architect. Certificates of compliance must be signed by materials producer and Contractor.

1.06 PRE-INSTALLATION CONFERENCE

A. Schedule a pre-installation conference at Cass Ave, Detroit MI-48201, minimum two weeks prior to start of concrete work containing waterproofing admixture, with the following parties in attendance.
   1. Owner's Representative.
   3. Contractor.
   4. Concrete Supplier.
   5. Concrete Contractor.
   6. Waterproofing admixture supplier.
   7. Waterproofing admixture manufacturer's representative.
   8. Other interested parties.

B. Review methods and procedures related to use of waterproofing admixture in cast-in-place concrete including, but not limited to, the following:
   1. Inspect and discuss condition of subgrade and preparatory work performed by other trades.
   2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   3. Review required inspecting, testing, and certifying procedures.
   4. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions.

C. Contractor shall record discussion, including agreement or disagreement on significant matters. Furnish copies of report to all parties present within 5 days after meeting date.
   1. If substantial disagreements exist at conclusion of meeting, determine how disagreements will be resolved, and set date and time to reconvene meeting.
1.07 MOCK-UPS

A. General: Prior to installing cast-in-place concrete, construct mockups for selection of each finish required to demonstrate aesthetic effects as well as qualities of materials and execution.
   1. Construct mock-ups minimum 30 days prior to start of Work using same personnel, materials, and techniques to be used for Project work.
   2. Construct mock-ups to demonstrate levels of the following finishes:
      a. Light Abrasive Blast finish for exposed exterior vertical surfaces.

B. Build mock-ups to comply with the following requirements, using materials indicated for Work.
   1. Locate mockups on-site in location indicated or, if not indicated, as directed by Architect.
   2. Size of mock-ups shall be minimum 5 feet by 5 feet.
   3. Construct 4 mock-ups for each finish required to demonstrate range available. Provide additional mock-ups, if requested by Architect.
   4. Notify Architect 7 days in advance of the dates and times when mock-ups will be constructed.
   5. Obtain Architect's approval of mock-ups and final selection of finish level before start of Work.
   6. Retain and maintain selected mock-ups during construction in an undisturbed condition as a standard for judging the completed Work.
      a. When directed, demolish and remove mockups from Project site.

PART 2 PRODUCTS

2.01 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
   1. Unfinished.
C. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.
   1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
D. Fiber Reinforcement: ASTM C 1116, Type III, engineered polypropylene fibers designed for secondary reinforcement of concrete fill at metal pan stairs.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Forta Corp.; Forta CR.
      b. Fibermesh, Inc.; Fibermesh.
      c. Degussa Admixtures, Inc.; Grace Fibers.

2.02 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I.
   1. Type III may be used for high early strength concrete.
   2. Use one brand of cement throughout the project, unless otherwise acceptable to Architect.
B. Normal Weight Aggregates: ASTM C 33.
   1. Fine Aggregates: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances.
      a. Dune sand, bank run sand and manufactured sand are not acceptable.
2. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
   a. Crushed stone, processed from natural rock or stone.
   b. Washed gravel, either natural or crushed. Use of pit or bank run gravel not permitted.
   c. Maximum Aggregate Size: Not larger than one-fifth of narrowest dimension between sides of forms, one-third of depth of slabs, nor three-fourths of minimum clear spacing between individual reinforcing bars or bundles of bars.

D. Fly Ash: ASTM C 618, Type F.
F. Water: Potable.
G. Colored Concrete Stain: Refer to Section 03 35 19 - Color Concrete Finishes.

2.03 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
B. Water-Reducing Admixture: ASTM C 494, Type A, and contain not more than 0.1% ions.
C. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C 494, Type F or Type G and contain not more than 0.1% chloride ions.
D. Water-Reducing, Non-Chloride Accelerator Admixture: ASTM C 494, Type E, and containing not more than 0.1% chloride ions.
F. Water-Reducing, Retarding Admixture: ASTM C 494, Type D, and contain not more than 0.1% chloride ions.
G. Certification: Provide admixture manufacturer’s written certification that chloride ion content complies with specified requirements.
H. Prohibited Admixtures: Calcium chloride thyocyanates or admixtures containing more than 0.1% chloride ions are not permitted.

2.04 WATERSTOPS

A. Waterstops: Provide flat, dumbbell type or centerbulb type waterstops at construction joints and other joints as indicated on Drawings. Size to suit joints.
   1. Rubber Waterstops: Corps of Engineers CRD-C 513.
   3. Bentonite/Butyl Waterstops: CETCO; Waterstop RX.

2.05 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, approximately 9 oz. per square yard.
B. Moisture-Retaining Cover: ASTM C 171, as follows:
   1. Waterproof paper.
   2. Polyethylene film.
   3. Polyethylene-coated burlap.
2.06 JOINT MATERIALS

A. Preformed Expansion Joint Fillers: ASTM D 1751 and AASHTO M 213, resilient and non-extruding type pre-molded bituminous impregnated fiberboard units.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Knight-Celotex; Conflex Expansion Joint Filler
      b. W.R. Meadows, Inc.; Fiber Expansion Joint Filler
   2. Expansion Joint Filler Caps: Provide removable caps for all preformed expansion joint fillers. Provide caps by the following:
      a. Bometals, Inc.; Expansion Board Caps
      b. W. R. Meadows; Sealight Snap-Cap

B. Epoxy Control Joint Filler: Two component, 100 percent solids compound, with minimum Shore D Hardness of 50.
   1. Subject to compliance with requirements, provide products by the following:
      a. Dayton Superior Corp.; Poxy-Fil (J-52)
      b. L & M Construction Chemicals, Inc.; Epoflex SL

2.07 UNDERSLAB VAPOR RETARDER

A. Vapor Barrier: Provide vapor barrier cover over prepared base material. Use polyethylene/polyolefin sheet per ASTM E 1745, Class A.
   1. Thickness: Not less than 10 mils per ACI 302.1R
   2. Water Vapor Transmission Rate: Maximum 0.01 perms tested per ASTM E154, Section 7 (based on ASTM E 96) or Test Method F1249. Refer to ASTM E1745 paragraph 7.
   3. Products: Subject to compliance with requirements, provide one of the following:
      a. Stego Industries; Stego Wrap Vapor Barrier.
      b. Raven Industries; Vapor Block 10.
      c. W. R. Meadows; Perminator 10 Mil.
      d. Inteplast; Barrier-Bac VB-250 (11 mil)
   4. Substitutions: See Section 01 25 00 - Substitution Procedures.

B. Accessories: Provide manufacturer's recommended accessories as required to provide a complete vapor barrier, including but not limited to seam tape and vapor-proof mastic/sealant.

C. Granular Base Course: Clean manufactured or natural sand; per ASTM D 448, Size 10, with 10 to 30 percent passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve.

2.08 RELATED MATERIALS

A. Dovetail Anchor Slots: Hot-dip galvanized sheet steel, not less than 0.366 inch thick (22 gage) with bent tab anchors. Fill slot with temporary filler or cover face opening to prevent intrusion of concrete or debris.

B. Bonding Compound: ASTM C 1059, Type II, styrene Butadiene or acrylic base, rewetable type.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dayton Superior Corp.; Day-Chem Ad Bond (J-40)
      b. Grace Construction Products; Daraweld C
      c. L & M Construction Chemicals; Everbond
      d. W. R. Meadows; Intralok

C. Epoxy Adhesive: ASTM C 881, two component, high modulus, moisture tolerant, structural epoxy adhesive suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dayton Superior Corp.; Resi-Bond (J-58)
   b. W. R. Meadows; Rezi-Weld
   c. Sika Chemical Corp.; Sikadur 32 Hi-Mod

2.09 PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301 Article 3.9. If trial batch method used, use an independent testing facility acceptable to Architect for preparing and reporting proposed mix designs.

   1. Testing facility shall not be same as used for field quality control testing, unless otherwise acceptable to Architect.
   2. Limit fly ash to maximum 15 percent of cement content by weight.

B. Submit written reports to Architect of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete productions until mixes have been reviewed and approved by Architect.

C. Design mixes to provide normal weight concrete with the following properties and additives:

   1. Footings and Foundations: 4000 psi 28-day compressive strength; W/C ratio, 0.50 maximum (non-air-entrained), 0.46 maximum (air entrained).
   2. Interior Slabs: 4000 psi 28-day compressive strength; W/C ratio, 0.50 maximum (non-air-entrained).
   3. Exterior Walls and Slabs: 4000 psi 28-day compressive strength; W/C ratio 0.40 (air entrained 6% plus or minus 1%).
   4. All Other Concrete: 4,000 psi 28-day compressive strength: W/C ratio, 0.50 maximum (non-air-entrained).

D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to Owner and as accepted by Architect.

   1. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in work.

E. Water-Cement Ratio: Provide concrete with maximum water-cement (WC) ratios as specified.

F. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

   1. Ramps, slabs, and sloping surfaces: Not more than 3 inches.
   2. Reinforced Foundation Systems: Not less than 1” and not more than 3 inches.
   3. Concrete containing HRWR admixture (super plasticizer): Not more than 8 inches after addition of HRWR to site verified 2 to 3 inches slump concrete.
   4. Other concrete: Not more than 4 inches.

2.10 ADMIXTURE USE

A. Use water-reducing admixture or high range water-reducing admixture (super plasticizer) in concrete as required for placement and workability.

B. Use non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 degF (10 degC).
C. Use high-range water-reducing admixture in pumped concrete, architectural concrete and concrete with water/cement ratios below 0.50.

D. Use air-entraining admixture in exterior exposed concrete, unless otherwise indicated. Add air-entrained admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus-or-minus 1% within following limits:
1. Concrete structures and slabs exposed to freezing and thawing, de-icer chemicals, or subjected to hydraulic pressure.
   a. Air Entrainment: 5.0%.
2. Other Concrete (not exposed to freezing, thawing or hydraulic pressure): 2% to 4% air.

E. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.

2.11 MIXES

A. Ready-Mix Concrete: Comply with ASTM C 94 and ASTM C 1116, and as herein specified.
   1. Furnish Batch Ticket information.
   2. When air temperature is between 85 degF (30 degC) and 90 degF (32 degC), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 degF (32 degC), reduce mixing and delivery time to 60 minutes.

PART 3 EXECUTION

3.01 GENERAL

A. Coordinate installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

3.02 FORMS

A. Design, erect, support, brace and maintain formwork, per ACI 301, to support vertical and lateral, static and dynamic loads that might be applied until such loads can be supported by concrete structure.
   1. Construct formwork as required so concrete members and structures are of correct size, shape, alignment, elevation and position. Maintain formwork construction tolerances per ACI 117 and ACI 347.
   2. Provide Class A tolerances for concrete exposed to view.
   3. Provide Class C tolerances for other concrete surfaces.

B. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.

C. Construct forms to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.
   1. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work.
   2. Single use spiral type forms are NOT ACCEPTABLE.

D. Fabricate forms for easy removal without hammering or prying against concrete surface.
   1. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces
   2. Provide top forms for inclined surfaces where slope too steep to place concrete with bottom forms only
3. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal

E. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Locate temporary openings in forms at inconspicuous locations.

F. Chamfer exposed corners and edges as indicated, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

G. Form Ties: Use specified type, sized as required to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

H. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support work of other trades built into forms.

I. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before placing concrete. Retighten forms and bracing after concrete placement as required to eliminate mortar leaks and maintain proper alignment.

J. Edge Forms and Screed Strips for Slabs: Set edge forms of bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units to support types of screed strips by use of strike-off templates or compacting type screeds.

3.03 PLACING REINFORCEMENT

A. Comply with CRSI's recommended practice for “Placing Reinforcing Bars”, for details and methods of reinforcement placement and supports, and as herein specified.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder prior to placing concrete.

2. Clean reinforcement of loose rust and mill scale, earth, ice and other materials which reduce or destroy bond with concrete.

B. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

C. Place reinforcement to obtain at least minimum coverage for concrete protection per ACI 318.

1. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations.

2. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

D. Install welded wire fabric in as long lengths as practicable.

1. Place on bar supports spaced to minimize sagging.

2. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.04 VAPOR RETARDER INSTALLATION

A. Place granular base course on slab sub-base material to minimum 4 inch thickness, unless otherwise indicated.

1. Level and compact to tolerance of plus 0 inch, minus 3/4 inch.

B. Following leveling and compacting of granular base for slabs on grade, place vapor retarder sheet with longest dimension parallel with direction of pour.

C. Place vapor retarder directly on compacted sand cushion.

D. Place, protect, and repair vapor retarder per ASTM E 1643.
1. Lap joints 6" and seal with appropriate tape.
2. Lap vapor barrier over footings or seal to foundation walls. Use manufacturer’s approved methods for sealing to foundation and walls.
3. Seal all penetrations with boots recommended by manufacturer.
4. Place patches over damaged areas, overlapping damage minimum 6 inches. Tape complete perimeter of patches.

3.05 JOINTS

A. Construction Joints: Locate and install construction joints as indicated, if not indicated, locate so not to impair strength and appearance of structure, as acceptable to Architect.
B. Provide keyways at least 1-1/2" deep in construction joints in slabs; accepted bulkheads designed for this purpose may be used for slabs.
C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints.
D. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Support and protect exposed waterstops during progress of work. Field fabricate joints in waterstops in accordance with manufacturers instructions.
E. Isolation Joints in Slabs-On-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams and elsewhere as indicated.
F. Contraction (Control) Joints in Slabs-On-Ground: Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Saw cut 1/8" to 1/4" wide x 1/4 of slab depth, unless otherwise indicated.
   1. Place sawcut joints as soon as possible, no later than 24 hours, after slab finishing is complete, and without dislodging aggregate.
   2. If joint pattern is not shown, provide joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

3.06 INSTALLATION OF EMBEDDED ITEMS

A. General: Set and build into work anchorage devices and other embedded items required for other work attached to, or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions and direction provided by suppliers of items to be attached thereto.
B. Install dovetail anchor slots to receive masonry anchors, in concrete structures as indicated on Drawings.

3.07 PREPARATION OF FORM SURFACES

A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface conditions.
B. Coat contact surfaces of forms with an approved, nonresidual, low VOC, form-coating agent before reinforcement is placed.
   1. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.
C. Thin form-coating compounds only with thinning agent of type, and in amount, and under conditions of form-coating compound manufacturer’s directions.
3.08 CONCRETE PLACEMENT

A. Preplacement Inspection: Before placing concrete, inspect and complete formwork installation of reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

1. Notify Architect when forms and reinforcing are in place and may be examined. Do not place concrete until authorized by Architect.

B. Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.

1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed against concrete which has hardened sufficiently to cause formation of seams or planes of weakness.

2. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

3. Protect adjacent finish materials against spatter during concrete slab placement.

C. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete per ACI 309R.

2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer.

3. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

D. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

1. Consolidate concrete during placing operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

2. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to start of finishing operations.

3. Maintaining reinforcing in proper position on chairs during concrete placement operations.

E. Placing Concrete Footings: Once excavation is complete, protect bearing strata from being disturbed. If soil is susceptible to disturbance due to moisture conditions, place concrete immediately.

F. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperature, in compliance with ACI 306 and as herein specified.

1. When air temperature has fallen to or is expected to fall below 40 degF (4 degC), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degF (10 degC), and not more than 80 degF (27 degC) at point of placement.

2. Do not use frozen materials or material containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt and other materials containing anti-freeze agents or chemical accelerators, unless otherwise accepted in mix designs.

G. Protections of Footings Against Freezing: Cover completed work at footing level with sufficient temporary or permanent cover, as required, to protect footings and adjacent subgrade from freezing; maintain as required.

H. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
   1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degF (32 degC). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
   2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
   3. Fog spray forms, reinforcing steel and subgrade just before concrete is placed. Keep subgrade uniformly moist, without puddles or dry spots.
   4. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

3.09 FINISH OF FORMED SURFACES

A. Rough Form Finish: For formed concrete surfaces not exposed-to-view in finish work or covered by other construction, unless otherwise indicated.
   1. This is the as-cast concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

B. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are to be covered with a coating material, or a covering material, applied directly to concrete, such as waterproofing, painting or similar system.
   1. This is as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams.
   2. Repair and patch defective areas with fins or other projections completely removed and smoothed.

C. Smooth Rubbed Finish: Provide smooth rubbed finish on exposed walls at areas scheduled/indicated, that have received smooth form finish treatment, not later than one day after form removal.
   1. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is produced.
   2. Do not apply cement grout other than that created by the rubbing process.

D. Related Unformed Surfaces: At unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.10 MONOLITHIC SLAB FINISHES

A. Scratch Finish: Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, portland cement terrazzo, and other bonded, applied cementitious finish flooring material, and where indicated.
1. After placing slabs, plane surfaces to tolerances of F(f) 15 (floor flatness) and F(l) 13 (floor levelness) measured per ASTM E 1155. Uniformly slope surfaces to drains. After leveling, roughen surface before final set, with stiff brushes, brooms, or rakes.

B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes specified; slab surfaces to be covered with waterproofing, membrane roofing, or sand-bed terrazzo, and where indicated.
   1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating.
   2. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units.
   3. Check and level surface plane to tolerance of F(f) 18 (floor flatness) and F(l) 15 (floor levelness) measured per ASTM E 1155. Cut down high spots and fill low spots. Uniformly slope surfaces to drains.
   4. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

C. Trowel Finish: Apply trowel finish to interior monolithic slab surfaces exposed to view, and slab surfaces to be covered with resilient flooring, carpet, ceramic tile, quarry tile, paint, or other thin film finish system, which have been float finish.
   1. After floating, begin first trowel finish operation using a power driven trowel.
   2. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances F(f) 20 (floor flatness) and F(l) 17 (floor levelness) measured per ASTM E 1155.
   3. Grind smooth surface defects which would telegraph through applied floor covering system.

D. Trowel and Fine Broom Finish: Where ceramic tile, porcelain tile, and quarry tile are to be installed with thin set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface with fine brooming.

E. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on Drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

C. Steel Pan Stairs: Provide fiber reinforced concrete fill for steel pan stair treads, landings, and associated items. Cast in safety inserts and accessories as shown on Drawings. Screed, tamp, and finish concrete surfaces as scheduled.

3.12 CONCRETE CURING AND PROTECTION

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
   1. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than 7 days.
2. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days per ACI 301 procedures. Avoid rapid drying at end of final curing period.

B. Curing Methods: Perform curing of concrete by moist curing, by moisture-retaining cover curing, and by combination thereof, as herein specified.
1. Provide moisture curing by following methods.
   a. Keep concrete surface continuously wet by covering with water.
   b. Continuous water-fog spray.
   c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
2. Provide moisture-cover curing as follows:
   a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

C. Curing Formed Surfaces: Cure formed concrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

D. Curing Unformed Surfaces: Cure unformed surfaces and other flat surfaces by use of moisture-retaining cover, unless otherwise directed.

E. Protect all concrete slabs indicated on Room Finish Schedule to be stained/sealed/colored concrete as follows:
   1. Sweep up all grit and debris immediately. Do NOT use oil based sweeping compounds.
   2. Use cleaner approved by sealer/hardener manufacturer for removing fine dust and grime on a daily basis. Avoid harsh chemicals.
   4. Do not eat or drink on slab.
   5. Remove isolated staining with specialty cleaner approved by sealer/hardener manufacturer.
   6. Get authorization from Contractor to operate equipment on the slab. Diaper all equipment and protect slab with absorbent drop cloth when working on slab.
      a. Use non-marking tires on all equipment. Inspect tires and remove embedded debris that may scratch slab.
   7. Store and charge materials and equipment in designated areas only. Contractor shall select location to minimize soiling and damage to slab to remain exposed.
   8. Use temporary, breathable protective coverings as needed for access. Remove coverings immediately after work is complete.

3.13 REMOVAL OF FORMS

A. Formwork not supporting weight of concrete may be removed after cumulatively curing at not less than 50 degF (10 degC) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete may not be removed in less than 14 days and until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members, or by use of nondestructive testing method acceptable to Architect.
C. Form facing material may be removed 4 days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

3.14 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in work. Apply new form coating compound as specified for new formwork.
   1. Split, frayed, delaminated or otherwise damaged form facing material is not acceptable for exposed surfaces.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces and remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use “patched” forms for exposed concrete surfaces, except as acceptable to Architect.

3.15 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Architect.
   1. Cut out honeycomb, rock pockets, voids over 1/4” in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1”. Make edges of cuts perpendicular to concrete surface. Thoroughly clean, dampen with water and brush-coat area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.
   2. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching.
   3. Compact mortar in place and strike-off slightly higher than surrounding surface.

B. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect.
   1. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on the surface; and stains and other discoloration that can not be removed by cleaning.
   2. Flush out form tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.
   3. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

C. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness using a template having required slope.
   1. Repair finished unformed surfaces that contain defects which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01” wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets and other objectionable conditions.
   2. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.
   3. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Architect.
D. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete.
   1. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound.
   2. Mix patching concrete of same materials to provide concrete of same type or class as original concrete.
   3. Place, compact and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

E. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method.
   2. Mix dry-pack, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
   3. Place dry pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.
   4. Perform structural repairs with prior approval of Architect for method and procedures, using specified epoxy adhesive and mortar.

F. Repair methods not specified above may be used, subject to acceptance of Architect.

3.16 FIELD QUALITY CONTROL

A. WSU will employ a testing laboratory to perform tests and to submit test reports.

B. Sampling and testing for quality control during placement of concrete may include the following, as directed by Architect.
   1. Sampling Fresh Concrete: ASTM C 172, except modified for slump per ASTM C 94.
      a. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
      b. Air Content: ASTM C 173, volumetric method or ASTM C 231 pressure method; one for each day's pour of each type of air-entering compound.
      c. Concrete Temperature: ASTM C 1064, test hourly when air temperature is 40 degF (4 degC) and below, and when 80 degF (27 degC) and above; and each time a set of compression test specimens are made.
      d. Compression Test Specimens: ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
      e. Compressive Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cubic yards plus additional sets for each 50 cubic yards over and above the first 25 cubic yards of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
   2. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
   3. When total quantity of a given class of concrete is less than 50 cubic yards, strength test may be waived by Architect if, in his judgement, adequate evidence of satisfactory strength is provided.
   4. When strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
5. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive by more than 300 psi.

C. Report test results in writing to the Architect, Contractor, and Contractor within 24 hours after tests.  
   1. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day and 28-day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted, but shall not be used as the sole basis for acceptance or rejection.

E. Additional Tests: Testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained, as directed by the Architect.  
   1. Testing service may conduct tests to determine adequacy of concrete by cored cylinders per ASTM C 42, or by other methods as directed.  
   2. Contractor shall pay for such tests conducted and any other additional testing as may be required, when unacceptable concrete is verified.

F. Measure floor and slab flatness and levelness per ASTM E 1155 within 24 hours of finishing.

3.17 PROTECTION

A. Protect all concrete slabs to receive exposed concrete finishes for petroleum staining, including but not limited to sealed/hardened, polished concrete or dyed and stained concrete floors

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Precast structural concrete.
   2. Precast structural concrete with commercial architectural finish.

B. Related Requirements:
   1. Section 033000 "Cast-in-Place Concrete" for placing connection anchors in concrete.
   2. Section 051200 "Structural Steel Framing" for furnishing and installing connections attached to structural-steel framing.
   3. Section 055000 "Metal Fabrications" for kickers and other miscellaneous steel shapes.
   4. Section 071900 "Water Repellents" for water-repellent finish treatments.

1.3 DEFINITIONS


1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each precast concrete mixture. Include compressive strength and, if required, water-absorption tests.

C. Shop Drawings:
   1. Submit a detailed shop drawings and design calculations sealed by a professional engineer registered in the state of Michigan.
   2. Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
3. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.

4. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.

5. Indicate separate face and backup mixture locations and thicknesses.

6. Indicate type, size, and length of welded connections by AWS standard symbols.

7. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.

8. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.

9. Include and locate openings larger than 10 inches (250 mm). Where additional structural support is required, include header design.

10. Indicate location of each precast structural concrete unit by same identification mark placed on panel.

11. Indicate relationship of precast structural concrete units to adjacent materials.

12. Indicate locations, dimensions, and details of thin-brick units, including corner units and special shapes, and joint treatment.

13. Indicate locations, dimensions, and details of stone facings, anchors, and joint widths.

14. Indicate shim sizes and grouting sequence.

15. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

D. Samples:

1. For each type of finish indicated on exposed surfaces of precast structural concrete units with architectural finish, in sets of three, representative of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches (300 by 300 by 50 mm).
   a. Where other faces of precast concrete unit are exposed, include Samples illustrating workmanship, color, and texture of backup concrete as well as facing concrete.

E. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Show precast structural concrete unit types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from precast structural concrete.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, fabricator and testing agency.

B. Welding certificates.

C. Material Certificates: For the following:

1. Cementitious materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
5. Insulation.
D. Material Test Reports: For aggregates, by a qualified testing agency.

E. Preconstruction test reports.

F. Source quality-control reports.

G. Field quality-control and special inspection reports.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Designated as a PCI-certified plant:

B. Installer Qualifications: A precast concrete erector qualified and designated by PCI's Certificate of Compliance, to erect Category S1 – Simple and Category S2 - Complex Structural Systems.

C. Installer Qualifications: An experienced precast concrete erector who has retained a "PCI-Certified Field Auditor" to conduct a field audit of a project installed by erector in Category S1 – Simple and Category S2 - Complex Structural Systems and who can produce an Erectors' Post Audit Declaration, according to PCI MNL 127, "PCI Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products."

D. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

E. Quality-Control Standard: For manufacturing procedures, testing requirements, and quality-control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

F. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

G. Sample Panels: After sample approval and before fabricating precast structural concrete units with architectural finish, produce a minimum of two sample panels approximately 16 sq. ft. (1.5 sq. m) in area for review by Architect. Incorporate full-scale details of architectural features, finishes, textures, and transitions in sample panels.

1. Locate panels where indicated or, if not indicated, as directed by Architect.
2. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.
3. After approval of repair technique, maintain one sample panel at fabricator's plant and one at Project site in an undisturbed condition as a standard for judging the completed Work.
4. Demolish and remove sample panels when directed.

H. Mockups: After sample panel approval but before production of precast structural concrete units with architectural finish, construct full-sized mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.
1. Build mockup as indicated on Drawings including sealants and precast structural concrete units with an architectural finish complete with anchors, connections, flashings, and joint fillers.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 COORDINATION

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.

B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

   1. Store units with dunnage across full width of each bearing point unless otherwise indicated.
   2. Place adequate dunnage of even thickness between each unit.
   3. Place stored units so identification marks are clearly visible, and units can be inspected.

C. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.

D. Lift and support units only at designated points indicated on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design precast structural concrete units.

B. Design Standards: Comply with ACI 318 (ACI 318M) and with design recommendations in PCI MNL 120, “PCI Design Handbook - Precast and Prestressed Concrete,” applicable to types of precast structural concrete units indicated.

C. Fire-Resistance Calculations: Where indicated, provide precast structural concrete units whose fire resistance meets prescriptive requirements of authorities having jurisdiction or has been calculated according to ACI 216.1 (ACI 216.1M) and PCI MNL 124, “Design for Fire Resistance of Precast Prestressed Concrete,” and is acceptable to authorities having jurisdiction.

D. Structural Performance: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated.
E. Structural Performance: Provide precast structural concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:

1. Dead Loads: Refer to Structural Drawings.
2. Live Loads: Refer to Structural Drawings.
3. Roof Loads: Refer to Structural Drawings.
5. Seismic Loads: Refer to Structural Drawings.
6. Wind Loads: Refer to Structural Drawings.
7. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain precast structural concrete deflections within limits of ACI 318 (ACI 318M).
   a. Thermal Movements: Allow for in-plane thermal movements resulting from annual ambient temperature changes of minus 18 to plus 120 deg F (minus 10 to plus 67 deg C).

8. Fire-Resistance Rating: Select material and minimum thicknesses to provide indicated fire rating.

2.2 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that provides continuous precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.

   1. Mold-Release Agent: Commercially produced form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

B. Form Liners: Units of face design, texture, arrangement, and configuration indicated or to match those used for precast concrete design reference sample. Furnish with manufacturer's recommended form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

C. Surface Retarder: Chemical set retarder, capable of temporarily delaying setting of newly placed concrete mixture to depth of reveal specified.

2.3 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A615/A615M, Grade 60 (Grade 420), deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M, deformed.

C. Steel Bar Mats: ASTM A184/A184M, fabricated from ASTM A615/A615M, Grade 60 (Grade 420), deformed bars, assembled with clips.

D. Plain-Steel Welded Wire Reinforcement: ASTM A185/A185M, fabricated from as-drawn steel wire into flat sheets.
2.4 PRESTRESSING TENDONS

A. Pretensioning Strand: ASTM A416/A416M, or Grade 270 (Grade 1860), uncoated, seven-wire, low-relaxation strand.


2.5 CONCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or Type III, gray, unless otherwise indicated.
   1. For surfaces exposed to view in finished structure, use gray or white cement, of same type, brand, and mill source.

B. Supplementary Cementitious Materials:
   1. Metakaolin: ASTM C618, Class N.
   2. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

C. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C33/C33M, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
   1. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
      a. Gradation: Uniformly graded
   2. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand compatible with coarse aggregate to match approved finish sample.

D. Coloring Admixture: ASTM C979/C979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.

E. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

F. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.

G. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
   1. Water-Reducing Admixtures: ASTM C494/C494M, Type A.
   2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. Water-Reducing and Accelerating Admixture: ASTM C494/C494M, Type E.
5. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
7. Plasticizing Admixture: ASTM C1017/C1017M, Type I.
8. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
9. Corrosion-Inhibiting Admixture: ASTM C1582/C1582M.

2.6 STEEL CONNECTION MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A36/A36M.
B. Carbon-Steel-Headed Studs: ASTM A108, Grade 1010 through 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.
C. Carbon-Steel Plate: ASTM A283/A283M, Grade C.
D. Malleable-Iron Castings: ASTM A47/A47M, Grade 32510 or Grade 35028.
E. Carbon-Steel Castings: ASTM A27/A27M, Grade 60-30 (Grade 415-205).
F. High-Strength, Low-Alloy Structural Steel: ASTM A572/A572M.
G. Carbon-Steel Structural Tubing: ASTM A500/A500M, Grade B or Grade C.
H. Wrought Carbon-Steel Bars: ASTM A675/A675M, Grade 65 (Grade 450).
I. Deformed-Steel Wire or Bar Anchors: ASTM A496/A496M or ASTM A706/A706M.
J. Carbon-Steel Bolts and Studs: ASTM A307, Grade A (ASTM F568M, Property Class 4.6); carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A563 (ASTM A563M); and flat, unhardened steel washers, ASTM F844.
K. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
   1. Finish: Plain.
L. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490 (Grade A490M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
M. Zinc-Coated Finish: For exterior steel items, steel in exterior walls, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A123/A123M.
   1. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.
   2. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.
N. Shop-Primed Finish: Prepare surfaces of nongalvanized-steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop apply lead-and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79 according to SSPC-PA 1.

O. Welding Electrodes: Comply with AWS standards.

P. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install precast structural concrete units.

2.7 BEARING PADS

A. Provide one of the following bearing pads for precast structural concrete units as recommended by precast fabricator for application:

1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore, Type A durometer hardness, ASTM D2240; minimum tensile strength 2250 psi (15.5 MPa), ASTM D412.

2. Random-Oriented-Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. 70 to 90 Shore, Type A durometer hardness, ASTM D2240; capable of supporting a compressive stress of 3000 psi (20.7 MPa) with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in Project.

3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; 80 to 100 Shore, Type A durometer hardness, ASTM D2240; complying with AASHTO’s “AASHTO LRFD Bridge Design Specifications,” Division II, Section 18.10.2; or with MIL-C-882E.

4. Frictionless Pads: PTFE, glass-fiber reinforced, bonded to stainless or mild-steel plate, or random-oriented-fiber-reinforced elastomeric pads; of type required for in-service stress.


2.8 ACCESSORIES

A. Reglets: Specified in Section 076200 "Sheet Metal Flashing and Trim."

B. Precast Accessories: Provide clips, hangers, high-density plastic or steel shims, and other accessories required to install structural precast concrete units.

2.9 GROUT MATERIALS

A. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107/C1107M, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218/C1218M.
2.10 INSULATED FLAT-WALL PANEL ACCESSORIES

A. Extruded-Polystyrene Board Insulation: ASTM C578, Type X, 1.30 lb/cu. ft. (21 kg/cu. m).

B. Wythe Connectors: manufactured to connect wythes of precast concrete panels.

2.11 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.

1. Limit use of fly ash to 20 percent replacement of portland cement by weight and ground granulated blast-furnace slag to 20 percent of portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.

B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 116 when tested according to ASTM C1218/C1218M.

D. Normal-Weight Concrete Mixtures: Proportion face and backup mixtures by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi (34.5 MPa).
2. Maximum Water-Cementitious Materials Ratio: 0.45.

E. Water Absorption: For structural precast concrete with an architectural finish, limit water absorption to 6 percent by weight or 14 percent by volume, tested according to ASTM C642, except for boiling requirement.

F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.

G. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

H. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.12 MOLD FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

1. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.
B. Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

1. Form joints are not permitted on faces of structural precast concrete with an architectural finish that is exposed to view in the finished work.
2. Edge and Corner Treatment: Uniformly chamfered or radiused.

2.13 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.

D. Cast-in openings larger than 10 inches (250 mm) in any dimension. Do not drill or cut openings or prestressing strand without Architect's approval.

E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds limits specified in ASTM A775/A775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
3. Place reinforcing steel and prestressing strand to maintain at least 3/4-inch (19-mm) minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches (38 mm) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

G. Prestress tendons for precast structural concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.
1. Delay detensioning or post-tensioning of precast, prestressed structural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete unit.

2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.

3. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.

4. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.

5. Protect strand ends and anchorages with a minimum of 1-inch- (25-mm-) thick, nonmetallic, nonshrink, grout mortar and sack rub surface. Coat or spray the inside surfaces of pocket with bonding agent before installing grout.

H. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

I. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.

1. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants." Ensure adequate bond between face and backup concrete, if used.

J. Comply with PCI MNL 116 procedures for hot- and cold-weather concrete placement.

K. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that does not show in finished structure.

L. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

M. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Architect's approval.

2.14 CASTING INSULATED WALL PANELS

A. Cast, screed, and consolidate wythe supported by mold.

B. Place insulation boards abutting edges and ends of adjacent boards. Insert wythe connectors through insulation, and consolidate concrete around connectors according to connector manufacturer's written instructions.

C. Ensure bottom wythe and insulation layer are not disturbed after bottom wythe reaches initial set.

D. Cast, screed, and consolidate top wythe to meet required finish.
E. Maintain temperature below 150 deg F (65 deg C) in bottom concrete wythe.

2.15 FABRICATION TOLERANCES

A. Fabricate precast structural concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 116 product dimension tolerances as well as position tolerances for cast-in items.

2.16 COMMERCIAL ARCHITECTURAL FINISHES

A. Manufacture member faces free of joint marks, grain, and other obvious defects with corners, including false joints, uniform and straight. Finish exposed-face surfaces of precast concrete units to match approved design reference sample, sample panels and mockups.

2.17 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

B. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements and ASTM C1610/C1610M, ASTM C1611/C1611M, ASTM C1621/C1621M, and ASTM C1712/C1712M.

1. Test and inspect self-consolidating concrete according to PCI TR-6.

C. Strength of precast structural concrete units is considered deficient if units fail to comply with ACI 318 (ACI 318M) requirements for concrete strength.

D. If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 (ACI 318M) requirements, employ a qualified testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C42/C42M.

1. A minimum of three representative cores shall be taken from units of suspect strength, from locations directed by Architect.
2. Test cores in an air-dry condition or, if units are wet under service conditions, test cores after immersion in water in a wet condition.
3. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
4. Report test results in writing on same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports include the following:

   a. Project identification name and number.
   b. Date when tests were performed.
   c. Name of precast concrete fabricator.
d. Name of concrete testing agency.
e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

E. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval. Architect reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Do not install precast concrete units until supporting, cast-in-place concrete has attained minimum allowable design compressive strength and until supporting steel or other structure is structurally ready to receive loads from precast concrete units.

3.2 INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, shoring, and bracing as required to maintain position, stability, and alignment of units until permanent connections are complete.

1. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.

2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.

3. Remove projecting lifting devices and use plastic patch caps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
1. Do not permit connections to disrupt continuity of roof flashing.

D. Field cutting of precast units is not permitted without approval of AOR/EOR.

E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.

F. Welding: Comply with applicable requirements in AWS D1.1/D1.1M and AWS D1.4/D1.4M for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

1. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
2. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil- (0.1-mm-) thick coat of galvanized repair paint to galvanized surfaces according to ASTM A780/A780M.
3. Visually inspect welds and remove, reweld, or repair incomplete and defective welds.

G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
2. For slip-critical connections, use one of the following methods to assure proper bolt pretension:
   c. Twist-off Tension Control Bolt: ASTM F3125/F3125M, Grade 1852.
   d. Direct-Tension Control Bolt: ASTM F3125/F3125M, Grade 1852.

3. For slip-critical connections, use method and inspection procedure approved by Architect and coordinated with inspection agency.

H. Grouting or Dry-Packing Connections and Joints: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled.

1. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces.
2. Fill joints completely without seepage to other surfaces.
3. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.
4. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
5. Keep grouted joints damp for not less than 24 hours after initial set.

3.3 ERECTION TOLERANCES

A. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.
B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Architect.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Erection of precast structural concrete members.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Visually inspect field welds and test according to ASTM E165 or to ASTM E709 and ASTM E1444. High-strength bolted connections are subject to inspections.

D. Testing agency will report test results promptly and in writing to Contractor and Architect.

E. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, shall be performed to determine compliance of replaced or additional work with specified requirements.

G. Prepare test and inspection reports.

3.5 REPAIRS

A. Repair precast structural concrete units if permitted by AOR/EOR.

1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780/A780M.

D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

E. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Architect.

3.6 CLEANING

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.

2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034100
SECTION 03 45 00
ARCHITECTURAL PRECAST CONCRETE

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Precast architectural concrete units (APC-1).
   2. Supports, anchors, and attachments.

1.2 COORDINATION
A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Design Mixes: For each precast concrete mixture. Include compressive strength and water-absorption tests.
C. Shop Drawings:
   1. Coordinated Shop Drawings: Prior to submitting shop drawings, coordinate with shop drawings for glazed curtain wall. Verify rough openings and connections and indicate confirmed dimensions and details.
   2. Indicate separate face and backup mix locations and thicknesses, if applicable.
   3. Indicate welded connections by AWS standard symbols. Detail loose and cast-in hardware, inserts, connections, and joints, including accessories.
   4. Indicate locations and details of anchorage devices to be embedded in other construction.
   5. Submit detailed shop drawings and design calculations sealed by a professional engineer registered in the state of Michigan.
D. (APC-1) Finish Sample: For each type of finish indicated on exposed surfaces of precast structural concrete units with architectural finish, in sets of 3, illustrating full range of finish, color, and texture variations expected; approximately 26.5 by 48 inches.
   1. Where other faces of precast concrete unit are exposed, include Samples illustrating workmanship, color, and texture of backup concrete as well as facing concrete.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
B. Welding certificates.
C. Source quality-control test reports.

1.5 QUALITY ASSURANCE
A. Fabricator Qualifications: A firm that complies with the following requirements and is experienced in manufacturing precast architectural concrete units similar to those indicated for this Project and with a record of successful in-service performance.
1. Assumes responsibility for engineering precast architectural concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

2. Participates in PCI’s Plant Certification program and is designated a PCI-certified plant for Group A, Category A1--Architectural Cladding and Load Bearing Units.

B. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

C. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, “Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.”

D. Installer Qualifications: An experienced installer who has completed precast architectural concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.


F. Mockups: Coordinate with Section 014339 - Mockups for integrated exterior wall mockup.

1.6 DELIVERY, STORAGE AND HANDLING

A. Transport, handle, store, and protect in accordance with manufacturer’s recommendations.

B. Handle precast members to position, consistent with their shape and design. Lift and support only from support points.

1. Lifting or Handling Equipment: Capable of maintaining units during manufacture, storage, transportation, erection, and in position for fastening.

C. Protect edges of members to prevent staining, chipping, or spalling of concrete.

PART 2 PRODUCTS

2.1 ARCHITECTURAL PRECAST CONCRETE

A. Fabricators:

1. Michigan:
   a. International Precast Solutions, LLC.
   c. Mack Industries, Inc.

B. (APC-1) Architectural Precast Concrete Units: Surface finish and dark integral color matching Architect’s sample.


2.2 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type III, gray or white, of same type, brand, and source.

B. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S.

1. Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining.
2.3 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from galvanized steel wire into flat sheets.

C. Supports: Manufacturer's bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place according to CRSI's "Manual of Standard Practice," PCI MNL 117, and as follows:
   1. For uncoated reinforcement, use CRSI Class 1 plastic-protected bar supports.

2.4 ANCHORS AND FASTENERS

A. Fabricate anchors from stainless steel, ASTM A 240 or ASTM A 666, Type 304; temper as required to support loads imposed without exceeding allowable design stresses. Fabricate dowels and pins for anchors from stainless steel, ASTM A 276, Type 304.

2.5 CONCRETE MIXES

A. Prepare design mixes for each type of concrete required.
   1. Limit use of fly ash and silica fume to not exceed, in aggregate, 25 percent of portland cement by weight.

B. Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast architectural concrete fabricator's option.

C. Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318.

D. Normal-Weight Concrete Face and Backup Mixes: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
   2. Maximum Water-Cementitious Materials Ratio: 0.45.

E. Water absorption: Not to exceed 5 percent to 6 percent by weight; except between 3 percent to 4 percent for sloping surfaces (sills), for improved weathering staining resistance, tested according to PCI MNL 117.

F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.

G. When included in design mixes, add other admixtures to concrete mixes according to manufacturer's written instructions.
2.6 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

B. Furnish loose steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast architectural concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in precast architectural concrete units to receive windows, cramps, dowels, reglets, waterstops, flashings, and other similar work as indicated.

D. Cast-in openings larger than 10 inches in any dimension.

   1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.
   2. Accurately position, support, and secure reinforcement against displacement during concrete placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
   3. Place reinforcement to maintain at least 3/4-inch minimum coverage. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
   4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Reinforce precast architectural concrete units to resist handling, transportation, and erection stresses.

G. Mix concrete according to PCI MNL 117 and requirements in this Section. After concrete batching, no additional water may be added.

H. Place face mix to a minimum thickness of 3 inches.

I. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units. Comply with requirements in PCI MNL 117 for measuring, mixing, transporting, and placing concrete.
   1. Place backup concrete to ensure bond with face mix concrete.

J. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL 117.

K. Identify pickup points of precast architectural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast architectural concrete unit on a surface that will not show in finished structure.

L. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.

M. Discard precast architectural concrete units that are warped, cracked, broken, spalled, stained, or otherwise defective unless repairs are approved by Architect.
N. Fabricate precast architectural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

O. Engraved Precast Concrete Cornerstone: Fabricate and install custom engraved panels as shown, with all components and accessories for complete installed assembly.
   1. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into panel surface indicated to produce precisely formed copy, incised to uniform depth.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Do not install precast concrete units until supporting concrete has attained minimum design compressive strength.

C. Provide for erection procedures and induced loads during erection. Maintain temporary bracing in place until final support is provided.

3.2 INSTALLATION

A. Install clips, hangers, and other accessories required for connecting precast architectural concrete units to supporting members and backup materials.

B. Install precast architectural concrete according to reviewed shop drawings and manufacturer instructions. Provide temporary supports and bracing as required to maintain position, stability, and alignment as units are being permanently connected.
   1. Install bearing pads as precast concrete units are being erected.
   2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
   3. Remove projecting hoisting devices and use sand-cement grout to fill voids within recessed hoisting devices flush with surface of concrete.

C. Anchor precast architectural concrete units in position by bolting, welding, grouting, or as otherwise indicated. Remove temporary shims, wedges, and spacers as soon as possible after anchoring and grouting are completed.

D. Welding: Perform welding in compliance with AWS D1.1 and AWS D1.4, with qualified welders.
   1. Protect precast architectural concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
   2. Repair damaged steel surfaces by cleaning and repriming damaged painted surfaces.

E. At bolted connections, use lock washers or other acceptable means to prevent loosening of nuts.

F. Grouting Connections: Grout connections where required or indicated. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.

3.3 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections.
B. Field welds and connections using high-strength bolts will be subject to tests and inspections.
C. Testing agency will report test results promptly and in writing to Contractor and Architect.
D. Remove and replace work that does not comply with specified requirements.
E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.4 INSTALLED WORK
A. Protection: Protect members from damage, excessive soiling at grade, run-off from roofs and other construction operations which could spray or flow on to precast panels.
   1. Provide noncombustible shields during welding operations.
B. Damaged Work:
   1. If permitted by Architect, repair exposed exterior surfaces of precast architectural concrete units to match color, texture, and uniformity of surrounding precast architectural concrete.
   2. Remove and replace damaged precast architectural concrete units if repairs are not allowed or if they do not comply with architect's requirements.
C. Cleaning: Clean exposed surfaces of precast concrete units after erection to remove weld marks, other markings, dirt, and stains.
   1. Wash and rinse according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
   2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

END OF SECTION
SECTION 03 45 10
PRECAST CONCRETE SITE WALLS

PART 1 - GENERAL
1.1 SUMMARY
A. Section Includes:
1. Precast Concrete Walls
2. Precast Concrete Ledges

1.2 REFERENCES
A. American Society for Testing and Materials (ASTM)
1. ASTM C-150  ASTM C-260  ASTM C-494  ASTM C-128  ASTM C-31
B. Precast Concrete Institute (PCI)

1.3 ACTION SUBMITTALS
A. Shop Drawings: Submit fabrication drawings of all precast concrete items showing detailed sections and profile for all precast items. Details shall show all reinforcing and cast in hardware.
B. Samples: For each exposed product and for each color and texture specified.
D. Performance Requirements
1. Compressive Strength 5,000 p.s.i. minimum
2. Air Content 6-8%
3. Water-Cement Ratio .45
E. Test Results
1. Manufacturer shall furnish test results attesting that materials meet specification requirements.

1.4 CLOSEOUT SUBMITTALS
A. Maintenance data.

1.5 QUALITY ASSURANCE
A. Comply with PCI Standards.
B. Precast manufacturing plant shall be certified, category AT – Architectural Trim, at the time of bidding.
C. Qualifications: Precast Concrete Manufacturer and Trade Contractor must have a minimum of 5 years of successful experience on projects of similar magnitude and complexity to the indicated project.
D. Manufacturer and contractor to be prequalified by Architect prior to bidding and failure to do so will void bid.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging and Shipping: precast concrete to be palletized, shrink wrapped and marked with legible manufacturer identification, including piece number and quantities.

B. Storage and Protection precast concrete to be stored in secure area in original packaging.

C. Protect from damage by other trades.

D. Report all damage due to shipment immediately. Customer is required to sign the Bill of Lading slip detailing the damaged product. Picture proof is required.

1.7 WARRANTY

A. For a period of two (2) years from delivery of precast concrete, manufacturer warrants the precast concrete products against defects in workmanship and materials per industry standards. This warranty does not cover the above products for cracking and faulting caused by settling due to improper or faulty substrates or improper installation; nor does it cover damage caused by impact, vandalism or natural disaster.

PART 2 - PRODUCTS

2.1 MANUFACTURER


B. Or approved equal.

2.2 FINISH

A. Custom color and finish to match Architect’s sample. G38 Night.

2.3 MATERIAL REQUIREMENTS


B. Aggregates: Aggregate shall be blended to meet individual project requirements.

C. Coloring; Pigments used shall be inorganic, resistant to alkalinity and used per manufacturer's recommendations.

D. Reinforcement and Hardware:
   1. Reinforce precast with deformed rods as recommended by precast concrete manufacturer.

E. Setting Materials, Caulks & Sealants
   1. Color(s) to be selected by Architect.
   2. Sealer: Colorless, pure acrylic water repellent sealer. Sealer to maintain natural look of concrete surface with no glaze or gloss, darkening or color change. Factory applied.

2.4 MANUFACTURED UNITS

A. Sizing Tolerances
   1. All units to conform to shop drawings with a (+/-) 1/8” tolerance in dimension.

B. Precast Surfaces and Edges:
   1. All exposed edges to have minimum of 1/8" radius to prevent chipping.
2. All finished surfaces to match approved control sample.
3. All precast concrete finished surfaces to be factory sealed.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine substrates for the following:
   1. Defects or cracks in existing work or substrate.
   2. Deviations beyond allowable tolerances for the substrate.
B. Continue with installation of precast units only when all defects have been corrected.

3.2 PROJECT CONDITIONS

A. Do not install products under environmental conditions outside setting material manufacturer’s absolute limits.

3.3 INSTALLATION

A. Precast Concrete products setting or installation methods are to be reviewed by the manufacturer and setting materials supplier.
B. Concrete substrate must be within a tolerance of 1/8” in all dimensions.
C. Place or screed mortar bed over primed substrate.
   1. Setting bed must be continuous under the entire length of the wall. Setting materials utilized per manufacturer’s recommended instruction.
   2. Set walls level and plumb to meet finish elevation.
D. Joints
   1. Joints between adjacent precast should be a minimum of 1/8”-1/4”.
E. Caulking of Precast
   1. Clean all joints thoroughly, removing all debris.
   2. Wipe all joints with caulk manufacturer’s recommended cleaner prior to application.
   3. Use urethane caulk. (Color match caulk to precast per architect selection.)
   4. Clean up after caulking as per caulk manufacturer’s recommendations.
F. Final Cleaning of Precast Concrete
   1. Check all surfaces and caulking, make repairs as necessary.
   2. Clean treads with a pH balanced soap.
G. Protection:
1. Upon completion, the work shall be ready for final inspection and acceptance by owner or owner’s agent.

2. General Contractor shall protect the finished work from the time the installing contractor completes the work.

H. Finish:

1. Overall match to approved sample and per industry standards.

2. All products to be factory sealed.

END OF SECTION
SECTION 042200
CONCRETE UNIT MASONRY

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Concrete masonry units (CMU).
   2. Mortar and Masonry Grout:
      a. Testing of mortar and masonry grout.
      b. Admixtures for mortar and masonry grout.
   3. Reinforcing and Anchoring Materials:
      a. Steel reinforcing bars.
      b. Masonry-joint reinforcement.
   4. Miscellaneous masonry accessories.
B. Related Requirements:
   1. Section 033000 - Cast-In-Place Concrete: For installation of inserts that are to be embedded in concrete or masonry, flashing reglets, and similar items to be used by Installer for anchoring, supporting, and flashing.
   2. Section 051200 - Structural Steel Framing items to be built into masonry work.
   3. Section 055000 - Metal Fabrications: For installation of metal fabrications, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

1.2 SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings:
   1. Masonry Units: Show sizes, profiles, coursing, locations of special shapes, pertinent dimensioning, layout, anchorages, construction details, methods of installation, adjacent construction and proposed anchoring. Show control- and expansion-joint layout.
   2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 318. Show elevations of reinforced walls.
C. Material Certificates: For each type and size of the following:
   1. Cementitious materials. Include name of manufacturer, brand name, and type.
   2. Mortar admixtures.
   3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
   4. Grout mixes. Include description of type and proportions of ingredients.
   5. Reinforcing bars.
   7. Anchors, ties, and metal accessories.

1.3 QUALITY ASSURANCE
A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.
1.4 DELIVERY, STORAGE, AND HANDLING
A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.5 FIELD CONDITIONS
A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 48 inches down both sides and hold cover securely in place.
   2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 48 inches down face next to unconstructed wythe and hold cover in place.
   3. Maintain protective boards at exposed external corners which may be damaged by construction activities. Provide such protection without damaging completed work.
   4. Provide temporary bracing during erection of concrete block work. Maintain in place until building structure provides permanent bracing.
   5. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. When ambient temperature is below 40 deg F comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

PART 2 PRODUCTS
2.1 CONCRETE UNIT MASONRY, GENERAL
A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.
B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source for each different product required for each continuous surface or visually related surfaces.
C. Shapes: Provide shapes indicated on Drawings and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

D. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated. Where required by Authorities Having Jurisdiction, units shall be listed and labeled by a qualified testing agency acceptable to Authorities Having Jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Concrete Masonry Units: ASTM C 90, load-bearing units of size as shown on Drawings.
   1. Density Classification: Normal weight, unless otherwise indicated.

B. Solid Units: ASTM C 90, medium weight units of size as shown on Drawings.

2.3 MORTAR AND GROUT MATERIALS

A. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

B. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction.
   1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
   2. Use same brand of cement, lime and aggregate throughout project to insure uniform mortar colors.

C. Hydrated Lime: ASTM C 207, Type S without air-entrainment.

D. Mortar Cement: ASTM C 1329.

E. Masonry Cement: Do not use masonry cement.

F. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

G. Aggregate for Mortar (Sand): ASTM C 144, and as follows:
   1. For joints less than 1/4 inch use aggregate graded with 100 percent passing No. 16 sieve.
   2. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.


I. Water: Potable.

2.4 REINFORCEMENT

A. Manufacturers:
   1. Dur-O-Wall.
   2. Hohmann & Barnard, Inc..
   3. Heckman Building Products.

B. Uncoated-Steel Reinforcing Bars: ASTM A 615 or ASTM A 996, Grade 60.

C. Wire Bar Type Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture according to CRSI’s “Manual of Standard Practice”.

D. Epoxy Coated Reinforcing Bars: ASTM A 775 or ASTM A 934, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.
1. Epoxy-Coated Supports and Tie Wire: For epoxy-coated reinforcement, use epoxy coated or other dielectric-polymer-coated wire bar supports.
2. Epoxy-Coated Steel Reinforcing Touch-up Coating: 3M Scotchkote 213PC or liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement and complying with ASTM A 775.

E. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

F. Horizontal Masonry Joint Reinforcement: Continuous Wire Joint Reinforcing with 9 gage side rods and crossrods. Use hot dipped galvanized wire ASTM A 153, Class B-2 (1.5 oz. PSF) for exterior masonry walls. Use mill galvanized wire ASTM A641. Class 1 (0.40 minimum zinc coating) for interior masonry walls. Use prefabricated corners and tees at wall intersections.

2.5 MORTAR AND GROUT MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.
1. Use portland cement-lime mortar, unless otherwise indicated.
2. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, or other admixtures unless otherwise indicated.
3. Do not use anti-freeze compounds to lower freezing point of mortar.
4. Do not use calcium chloride in mortar or grout.
5. Use mortar ingredients that will not produce efflorescence.
6. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer unless otherwise indicated. Discard mortar when it has reached initial set.

B. Mortar for Masonry Units:
1. Mortar for Non-Load Bearing Unit Masonry: ASTM C270, type as scheduled using Proportion or Property specification.

C. Schedule of Mortar Types: Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry:
1. Interior non-load-bearing partitions: Type N.
2. Exterior solid unit at stone veneer base: Type S

D. Grout for Unit Masonry: Comply with ASTM C476. For use in filling bond beams, concrete unit masonry cells with reinforcing bars, and other cells or cavities as indicated.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 7 in TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Use fine aggregate size No. 2 for fine grout and course aggregate size No. 8 for coarse grout in accordance with ASTM C404.
3. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.2.1 for specified 28-day compressive strength indicated, but not less than 3000 psi when tested in accordance with ASTM C1019.
4. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C143.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
   1. Ensure items built-in by other trades for this work are properly located and sized. Fill in solidly with masonry around and built-in items. Fill space between hollow metal frames and masonry solidly with mortar.

C. Establish lines, levels and coursing. Protect from disturbances.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 MIXING MORTAR AND GROUT

A. Mixing Masonry Mortar: Thoroughly mix in accordance with TMS 602-11 / ACI 530.1 / ASCE 6-11 in quantities needed for immediate use,
   1. Admixtures: Add in accordance with manufacturer’s recommendations. Ensure uniformity of mix and colorations.
      a. Consult with and follow manufacturer’s directions on use, mix designs and procedures, quantity and mixing of admixtures and various conditions affecting mixing and pouring. Show proposed admixtures on mix designs and do not use unless shown.
   2. Ensure that sand is uniformly damp immediately before mixing
   3. Maintain workability of mortar by remixing or re-tempering. Discard mortar which has begun to stiffen or is not used within 2-1/2 hours after initial mixing.

B. Mixing Masonry Grout: Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 for Fine or Course grout.
   1. Unless otherwise required, mix grout other than self-consolidating grout to a consistency that has a slump between 8 and 11 inches.
   2. Proportioning of self-consolidating grout at the project site is not permitted. Do not add water at the project site in accordance with the self-consolidating grout manufacturer’s recommendations.
   3. Add admixtures in accordance with manufacturer’s instructions. Mix thoroughly.

3.3 INSTALLATION, GENERAL

A. Thickness: Build masonry walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
F. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

G. Built-In Work: As work progresses, build-in items as indicated and required, including, hollow metal frames, window frames, steel angle lintels, nailing strips, anchor bolts, plates, sleeves, hangers, supports, and other items supplied by other trades.
   1. Wherever bolts, brackets and similar anchor items are cast-in masonry, fill voids in masonry with mortar to adequately anchor and transmit loads.
   2. Build-in items plumb and true.
   3. Bed anchors of hollow metal frames in mortar joints. Fill frame voids solid with mortar. Fill masonry cores at jambs with grout for full projection at frame anchors.
   4. Do not build-in organic materials which will be subjected to rot or deterioration.

H. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

3.4 TOLERANCES

A. Dimensions and Locations of Elements:
   1. Dimensions in Cross Section or Elevation: Do not vary by more than plus 1/2 inch or minus 1/4 inch.
   2. Location of Elements in Plan: Do not vary from that indicated by more than plus or minus 1/2 inch.
   3. Location of Elements in Elevation: Do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

3.5 CONCRETE MASONRY UNIT INSTALLATION

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets.
   1. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
   2. Place masonry in accordance with lines and levels indicated on drawings. Lay from exposed side, plumb, level and true to modular dimensions.

B. Bond Pattern: Unless otherwise indicated, lay exposed masonry in running bond, lapping not less than 4 inches. Bond and interlock each course of each wythe at corners.

C. Lay CMU as follows:
   1. Bed face shells in mortar and make head joints of depth equal to bed joints.
   2. Bed webs in mortar in all courses of piers, columns, and pilasters.
   3. Bed webs in mortar in grouted masonry, including starting course on footings.
   4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
   5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.
6. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

7. Install joint reinforcing, anchors and ties in full mortar surround and where necessary fill voids in blocks to provide full bed to completely imbed items.

D. Joint Tooling: Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

1. Strike joints flush where below grade and where indicated to receive waterproofing, cavity wall insulation, air or moisture barriers, unless otherwise indicated.

2. Strike joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3. Strike flush and then tool to dense sealed surface mortar joints that will be covered by earth.

4. Joints behind ceramic tile shall be flush.

5. Rake out mortar in preparation for application of sealants, where required.

E. Reinforced Unit Masonry: Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for placement of reinforcing, for cleanouts and for grout placement, including minimum grout space and maximum pour height.

F. Masonry-Cell Fill: Pour lightweight-aggregate fill into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than 20 feet.

G. Install steel lintels where indicated.

H. Interior Partitions: Carry masonry partitions up to structure above, unless otherwise noted.

1. Joint to Structure Above: Provide 3/8 inch joint between masonry and over-structure and pack solidly to form dense and effective barrier to sound transmission. Fill of voids shall permit movement and deflection.

2. Openings Through Walls: Except as otherwise indicated, where piping, conduit or similar features pass through walls, carefully fill spaces to block sound. Fill voids to permit movement and deflection. Fill solid around obstructions and voids to form effective closures.


I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.

2. Secure top of non-load bearing cmu partitions to structure above as indicated in drawings.

3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078446 - Fire-Resistive Joint Systems.

J. Isolate masonry partitions from vertical structural framing members with control joint, with mortar raked back 1/4 inch regardless of joint treatment.

K. Where piping and conduit run in masonry, work with other trades to coordinate work. Cut out center bridges in block to create voids for pipes or conduit. Where pipes or conduit exit from wall, drill neat holes to provide neat unpatched walls.

1. Review acoustic penetration details. A clear annular gap of ½” to 1” must be provided around all penetrating services (ductwork, piping, conduit, cable trays, etc.) to ensure no rigid contact.

2. No penetrating services shall be mounted to, hung from or otherwise supported by the blockwork partition.

3. review locations where isolation gap is required between blockwork walls and adjacent constructions. Assure that no mortar has fallen into gaps or otherwise compromised the acoustic separation provided by the air-gap or resilient gasket.
L. Cut and fit concrete block for chases, pipes, conduit, sleeves, and grounds. Cooperate with other sections of work to ensure correct size, shape and location. Provide not less than 8 inches of masonry between chase or recess and jamb of openings. Cut masonry units using motor-driven saws to provide clean, sharp, unchipped edges.

1. Obtain Architect's review prior to cutting or fitting any area not indicated on drawings, or which may impair appearance or strength of masonry work.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space continuous joint reinforcement not more than 16 inches o.c vertically.
2. Provide reinforcement not more than 8 inches above and below wall openings and extending 36 inches beyond openings in addition to continuous reinforcement.
3. Place joint reinforcement at bed joint at top course of wall or partition, continuous full length of wall.

B. Refer to Structural Drawings for locations of reinforcing bars within concrete masonry wall section.

C. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

D. Provide continuity by using prefabricated T-shaped unit at wall intersections and prefabricated L-shaped units at corners.

3.7 CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

1. Provide control joints in block work as indicated and where shown on Drawings, or if not shown, review locations with Architect prior to start of installation.
2. Form joints in brick and block work, straight and true.
3. Unless otherwise shown on Structural Drawings, end reinforcing approximately one inch either side of joints. Do not continue horizontal masonry reinforcing across joints.

B. Control Joints: Form control joints in concrete masonry as follows:

1. Provide control joints in block work as indicated and where shown on Drawings, or if not shown, locate at 40 feet maximum for horizontal run of wall.
2. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
3. Install preformed control-joint gaskets designed to fit standard sash block.
4. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
5. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.
6. Keyed Control Joint in Bond Beams: At continuous bond beams, provide keyed control joint at construction joints.
   a. Extend rebar beyond joint minimum of 18 inches.
   b. Use 2X wood block drilled to allow rebar to pass through wood block.
   c. Set block inside of bond beam and coat with form release agent.
   d. Secure block in place before pouring bond beam.

C. Expansion Joints: Form expansion joints in brick as follows:

1. Provide control joints in brick work as indicated and where shown on Drawings, or if not shown, locate at 30 feet maximum for horizontal run of wall.
a. Corners: Provide at 2 feet from building corners if not shown on Drawings.
2. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
3. Build flanges of factory-fabricated, expansion-joint units into masonry.
4. Build in compressible joint fillers where indicated.
5. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 079200 - Joint Sealants.

D. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 3/8 inch.
1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

E. Joint Fillers and Deflection Material: Install fillers in accordance with manufacturer's printed instructions. Compressible fillers shall be 50 percent larger than joint size.
1. Set at proper depth or position in joint to coordinate with other work, including installation of bond breakers, backer rods and sealants.
2. Do not leave voids or gaps between ends of joint filler units.
3. Recess exposed edges or faces or compressible fillers slightly behind adjoining surfaces so that compressed units will not protrude from joint.

3.8 REPAIRING AND CLEANING
A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

C. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry in accordance with BIA recommendations.

PROTECTION
A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

B. Adequately brace all work to prevent damage of any kind. Mask, barricade or similarly protect work as required from damage during building operations. Protect installed material as necessary to prevent staining or damage from the elements.

C. Provide temporary bracing of masonry during erection. Do not remove bracing until building structure provides permanent bracing.

D. During erection, keep all walls dry by covering the top with a strong, waterproof membrane at each shutdown and the end of each day. Cover partially completed walls at all times when work is not in progress. Extend cover a minimum of 2 feet down both sides, and securely hold in place.

END OF SECTION
SECTION 051200
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Structural steel.
      2. Prefabricated building columns.
      3. Field-installed shear connectors.
   B. Related Requirements:
      1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
      2. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
      3. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other steel items not defined as structural steel.

1.3 DEFINITIONS
   A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
   B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
   C. Heavy Sections: Rolled and built-up sections as follows:
      1. Shapes included in ASTM A6/A6M with flanges thicker than 1-1/2 inches (38 mm).
      2. Column base plates thicker than 2 inches (50 mm).

1.4 COORDINATION
   A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Cass Ave, Detroit MI-48201

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Shop Drawings: Show fabrication of structural-steel components.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment Drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.

D. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:
   1. Power source (constant current or constant voltage).
   2. Electrode manufacturer and trade name, for demand critical welds.

E. Delegated-Design Submittal: For structural-steel connections indicated to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and fabricator.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural steel, including chemical and physical properties.

E. Product Test Reports: For the following:
   1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   2. Direct-tension indicators.
   3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.
5. Shop primers.

F. Survey of existing conditions.
G. Source quality-control reports.
H. Field quality-control and special inspection reports.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P2 or to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

E. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 341 and AISC 341s1.
3. AISC 360.
4. RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers’ written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using schematic details indicated and AISC 360.
2. Use Allowable Stress Design; data are given at service-load level.
3. Design composite floor beams for design 75% of the uniform load carrying capacity published in table in the AISC code or the reaction indicated on the framing plans, whichever is greater. No connection shall have a capacity less than 6000 pounds.
4. Design Roof beams for 50% of the uniform load carrying capacity published in table in the AISC code or the reaction indicated on the framing plans, whichever is greater. NO connection shall have a capacity less than 6000 pounds.

B. Moment Connections: Type FR, fully restrained.

C. Construction: Combined system of moment frame, braced frame, and shear walls.

2.2 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:

1. W-Shapes: 60 percent.
2. Channels, Angles 60 percent.
3. Plate and Bar: 25 percent.
4. Cold-Formed Hollow Structural Sections: 25 percent.
5. Steel Pipe: 25 percent.
6. All Other Steel Materials: 25 percent.

C. W-Shapes: ASTM A992/A992M Or ASTM A572/A572M, Grade 50.

D. Channels, Angles: ASTM A36/A36M , Grade 36.

E. Plate and Bar: ASTM A36/A36M, Grade 36.

F. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B, structural tubing.

G. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
1. Weight Class: Standard.
2. Finish: Black, except where indicated to be galvanized.

H. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with plain finish.

B. High-Strength Bolts, Nuts, and Washers: ASTM A490, Type 1, heavy-hex steel structural bolts or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 490-1, compressible-washer type with plain finish.

C. Slip Critical Bolted Connections: Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-or round head assemblies consisting of steel structural bolts with splined ends; ASTM A563, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Plain.

D. Shear Connectors: ASTM A108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

E. Unheaded Anchor Rods: ASTM F1554, Grade 36 or ASTM F1554, Grade 55, weldable as indicated.

1. Configuration: Hooked typically, straight as indicated.
4. Washers: ASTM F436, Type 1, hardened carbon steel.
5. Finish: Plain.

F. Headed Anchor Rods: ASTM F1554, Grade 36 or ASTM F1554, Grade 55, weldable, straight.

3. Washers: ASTM F436, Type 1, hardened carbon steel.

G. Threaded Rods: ASTM A36/A36M Typically or ASTM A572/A572M, Grade 50 as indicated.

3. Finish: Plain.


I. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1030.


K. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Fluorocarbon Company Limited.

2. Mating Surfaces: PTFE and PTFE.

3. Coefficient of Friction: Not more than 0.03.

4. Design Load: Not less than 2,000 psi.

5. Total Movement Capability: 2 inches

2.4 PRIMER

A. Primer: SSPC-Paint 23, latex primer.

B. Galvanize miscellaneous framing and supports where exposed to the elements such as at the Building Exterior as well as interior locations which are humid or corrosive.

C. Preparation and Coating over Galvanized Steel:
   1. Preparation: All galvanized metal receiving additional coats shall be tested by use of a copper sulfate test. This includes using a 10% solution of copper sulfate dissolved in water and applied to the galvanized surface. The reaction time between the copper sulfate and zinc should result in turning the galvanized area black within 15 seconds or less. If the reaction takes longer than 15 seconds, further cleaning is required as follows:
      a. Preparation for TNEMEC paints: Apply Oakite CrysCoat 747 or 747 LTS as recommended by manufacturer. Allow to dry and air chuck entire prepared area removing excess materials.
      b. Preparation for Wasser paints: Apply Great Lakes Clean and Etch or Oakite 747 as recommended by manufacturer followed by a thorough rinse.
   2. Primer:
      a. TNEMEC: One (1) coat TNEMEC Series N 27 S.T. Typoxy @ 2.0 to 4.0 mil DFT.
      b. Wasser: One (1) coat of Wasser MC-CR @ 3.0-4.0 mils DFT.
   3. For warranty purposes, the Contractor shall insure that the intermediate and finish coats specified in Division 9 “Painting” and the applied primer specified above are from the same

D. Galvanizing Repair Paint: MPI#18, MPI#19, SSPC-Paint 20 or ASTM A780.

2.5 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
2.6 FABRICATION

   1. Camber structural-steel members where indicated.
   2. Fabricate beams with rolling camber up.
   3. Identify high-strength structural steel according to ASTM A6/A6M and maintain markings until structural steel has been erected.
   4. Mark and match-mark materials for field assembly.
   5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
   1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
   2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.7 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened unless noted Pretensioned or Slip critical on the drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.
2.8 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
   2. Surfaces to be field welded.
   4. Surfaces to receive sprayed fire-resistant materials (applied fireproofing).
   5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 3, "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
   2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils

2.9 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123/A123M.
   1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
   2. Galvanize lintels, shelf angles and welded door frames attached to structural-steel frame and located in exterior walls.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.
   1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections

B. Correct deficiencies in work that test reports and inspections indicate does not comply with the contract documents.
C. Bolted Connections: shop-bolted connections will be tested and inspected according to RCSC’s “Specification for Structural Joints Using ASTM A325 or A 490 Bolts.”

D. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency’s option:

1. Liquid Penetrant Inspection: ASTM E165.
2. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
4. Radiographic Inspection: ASTM E94.

E. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Pretension anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened unless noted Pretensioned or Slip critical on the drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerance.
3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage qualified special inspector to perform the following special inspections:
   1. Verify structural-steel materials and inspect steel frame joint details.
   2. Verify weld materials and inspect welds.
   3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Bolted Connections: Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."

D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.
   1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
      a. Liquid Penetrant Inspection: ASTM E165.
      b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
      c. Ultrasonic Inspection: ASTM E164.
      d. Radiographic Inspection: ASTM E94.

E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
   1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

F. Correct deficiencies in work that test reports and inspections indicate does not comply with the contract documents.

G. Additional inspecting, at Contractor's expense, will be performed to determine compliance of the corrected work with specified requirements.

H. Test results and inspection reports shall be reported in writing to Architect, Contractor, and Authorities having jurisdiction within 48 hours of testing.

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A780/A780M.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
END OF SECTION 051200

END OF SECTION
SECTION 05 21 00
STEEL JOIST FRAMING

PART 1 - GENERAL
1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   2. KCS-type K-series steel joists.
   3. Long-span steel joists LH and DLH.

B. Related Sections include the following:
   1. Division 04 Section "Unit Masonry" for installing bearing plates in unit masonry.
   2. Division 5 Section "Metal Fabrications" for furnishing steel bearing plates.

1.3 DEFINITIONS

A. SJI "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support non-uniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.

B. Structural Performance: Provide joists and connections capable of withstanding a net uplift force of 12 pounds per square foot.

C. Design special joists to withstand design loads with live load deflections no greater than the following:
   1. Floor Joists: Vertical deflection of 1/360 of the span.
   2. Roof Joists: Vertical deflection of 1/360 of the span.

1.5 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product Data: For each type of joist, accessory, and product indicated.

C. Shop Drawings: Show layout, designation, number, type, location, and spacings of joists. Include joining and anchorage details, bracing, bridging, joist accessories; splice and connection locations and details; and attachments to other construction.

   1. Indicate locations and details of bearing plates to be embedded in other construction.
2. Comprehensive engineering analysis and design of joists including diagrams, geometry, chord and web sizes and stress state of each member.
3. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

D. Welding certificates.
E. Manufacturer Certificates: Signed by manufacturers certifying that joists comply with requirements.
F. Mill Certificates: Signed by bolt manufacturers certifying that bolts comply with requirements.
G. Qualification Data: For manufacturer and professional engineer.
H. Research/Evaluation Reports: Evidence of steel joists’ compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables of SJI "Specifications."

1. Manufacturer must be certified by SJI to manufacture joists complying with SJI standard specifications and load tables.
2. Assumes responsibility for engineering special joists to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
3. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of joists that are similar to those indicated for this Project in material, design, and extent.

B. SJI Specifications: Comply with standard specifications in SJI's "Specifications" that are applicable to types of joists indicated.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."
B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel: Comply with SJI's "Specifications" for web and steel-angle chord members.
B. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A, carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.

1. Finish: Plain, uncoated.
C. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

1. Finish: Plain.
D. Welding Electrodes: Comply with AWS standards.
2.2 PRIMERS

A. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.3 K-SERIES STEEL JOISTS


B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.

C. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.

D. Provide holes in chord members for connecting and securing other construction to joists.

E. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."

F. Camber joists according to SJI's "Specifications."

G. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.4 LONG-SPAN STEEL JOISTS

A. Manufacture steel joists according to "Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as follows:


2. End Arrangement: Underslung.

3. Top-Chord Arrangement:
   a. LH: Parallel.
   b. DLH: Parallel.

B. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.

C. Provide holes in chord members for connecting and securing other construction to joists.

D. Camber long-span steel joists according to SJI's "Specifications."

E. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.5 JOIST ACCESSORIES

A. Bridging: Provide bridging anchors and number of rows of horizontal and/or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.

1. Bridging, including bolted x-bridging, indicated on the plans where it would not normally be required, shall be provided to supplement continuity of the lateral bracing system to:
   a. Support perimeter conventional framing, beams, posts for roof screens, etc.
   b. Offset bridging lines at roof openings, mechanical ductwork, etc.
B. Steel bearing plates with integral anchorages are specified in Division 05 Section "Metal Fabrications."

C. Supply miscellaneous accessories, including splice plates and bolts required by joist manufacturer to complete joist installation.

2.6 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by power-tool cleaning, SSPC-SP 3.

B. Apply 1 coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Do not connect bottom chord extensions to columns unless specifically indicated on the Drawings. If a connection is specified, delay rigidly connecting bottom-chord extensions to columns or supports until dead loads have been applied.

C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.


E. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Construction Manager/Owner will engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.

B. Field welds will be visually inspected according to AWS D1.1/D1.1M.

C. In addition to visual inspection, field welds will be tested according to AWS D1.1/D1.1M and the following procedures, as applicable:
4. Liquid Penetrant Inspection: ASTM E 165.

D. Bolted connections will be visually inspected.

1. High-strength, field-bolted connections will be tested and verified according to procedures in RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts."

E. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.

F. Additional testing will be performed to determine compliance of corrected Work with specified requirements.

G. Test results and Inspection Reports shall be reported in writing to Architect, Contractor, and Authorities having jurisdiction within 48 hours of testing.

3.4 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or re-prime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.

1. Clean and prepare surfaces by hand-tool cleaning, SSPC-SP 2, or power-tool cleaning, SSPC-SP 3.
2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

C. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, to ensure joists and accessories are without damage or deterioration at time of Substantial Completion.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

   A. This Section includes the following:

      1. Roof deck.
      2. Composite floor deck.

   B. Related Sections include the following:

      1. Division 03 Section “Cast-in-Place Concrete” for concrete fill.
      2. Division 05 Section “Structural Steel Framing” for shop- and field-welded shear connectors and field installed puddle welds.
      3. Division 05 Section “Metal Fabrications” for framing deck openings with miscellaneous steel shapes.

1.3 DEFINITIONS

   A. Action Submittals: Mandatory submittals by the Sub-Contractor which require action on the part of the General Contractor, Construction Manager and Design Professional.

      2. Design Professional: Review, Stamp and Return to the General Contractor or Construction Manager.

   B. Informational Submittals: Mandatory submittals by the Sub-Contractor to the General Contractor, Construction Manager and Design Professional which are not returned but kept by each for their project record.

1.4 ACTION SUBMITTALS

   A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

   B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.5 INFORMATIONAL SUBMITTALS

   A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

   B. Product Data: For each type of deck, accessory, and product indicated.

   C. Product Certificates: For each type of steel deck, signed by product manufacturer.

   D. Welding certificates.
E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners.

F. Research/Evaluation Reports: For steel deck.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

B. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Delivery:

1. Steel roof deck units shall be delivered to the job site in manufacturer's original, unopened bundles, containers and/or packaging.
2. Steel roof deck bundle labels shall clearly indicate:
   a. Product description.
   b. Manufacturer.
   c. Bundle weight.
   d. Number of pieces.
   e. Length.
   f. Bundle number.
   g. SDI approved installation safety warnings.
3. Note on shipper's bill of lading any material damage or shortages, before signing for material and notify the deck supplier immediately.

C. Storage:

1. Store materials in accordance with manufacturer's instructions.
2. Protect materials from corrosion, deformation, and other damage.
3. Store deck bundles off ground, with one end elevated to provide drainage.
4. Protect bundles against condensation with ventilated waterproof covering.
5. Stack bundles to prevent tipping, sliding, rolling, shifting, or material damage.
6. Check bundles for tightness and retighten as necessary to prevent wind from loosening sheets or working bundles apart.
7. Place deck bundles near main supporting beam at column or wall on building frame.
8. Do not place bundles on unbolted frames or on unattached or un-bridged joists.
9. Ensure structural frame is properly braced to receive bundles.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Steel Deck:
2.2 MATERIALS

A. Steel: Comply with AISI and SDI's "Specifications" for deck design and fabrication.

2.3 ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:

1. Galvanized Steel Sheet: ASTM A 63/A 653M, Structural Steel (SS), Grade 40, G60 zinc coating.
2. Deck Profile: Type WR, wide rib.
3. Profile Depth: 1-1/2 inches.
4. Design Uncoated-Steel Thickness: As indicated.
5. Span Condition: Triple span or more.
6. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.4 COMPOSITE FLOOR DECK

A. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:

1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 50, G60 zinc coating.
2. Profile Depth: 2 inches and 3 inches.
3. Design Uncoated-Steel Thickness: As indicated.
4. Span Condition: Triple span or more.

2.5 NON-COMPOSITE FORM DECK

A. Non-composite Steel Form Deck: Fabricate ribbed-steel sheet non-composite form-deck panels to comply with "SDI Specifications and Commentary for Non-composite Steel Form Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:

1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 50, G60 zinc coating.
2. Profile Depth: 2 inches and 3 inches.
3. Design Uncoated-Steel Thickness: As indicated.
4. Span Condition:
   a. Typically: Triple span or more.
   b. At Entrance Slabs: Single span unless noted otherwise.
5. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.6 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 30 for overhang and slab depth.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

H. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

I. Galvanizing Repair Paint: ASTM A 780 or SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
1. Use correct welding heat as required to avoid burning completely through deck and support beams or joists. Welds installed in this fashion will be rejected and repaired, including reinforcement of supporting beams or joists, at the Contractor’s expense.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions in order to meet or exceed diaphragm strength obtained by specified welding pattern. Submit proposed mechanical fastening pattern to the Engineer for review prior to deck installation.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:

2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated, but not less than 12 inches apart in the field of roof and 6 inches apart in roof corners and perimeter, based on roof-area definitions in FMG Loss Prevention Data Sheet 1-28.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals as indicated, but not exceeding the lesser of 1/3 of the span and as follows:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum.

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld flanges to top of deck. Space welds not more than 12 inches apart with at least one weld at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and weld.

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer’s written instructions. Weld to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.

3.4 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.
3. Weld Spacing: Space and locate welds as indicated.
4. Provide powder actuated pins or nails to connect form to supporting foundation walls at entrance slabs.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches, with end joints as follows:

1. End Joints: Lapped at non-composite deck.

2. End Joints: Butted at composite deck.

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Construction Manager/Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.


B. Field welds will be subject to inspection.

1. Inspector is to note and reject all unsatisfactory puddle welds including those in which excessive welding heat has been used resulting in the deck and/or supporting beams or joists being burnt through.

2. Rejected welds must be repaired including reinforcement of supporting beams or joists, at the Contractor’s expense.

3. The final Inspection Report shall note compliance with the specified size, spacing and quality of all puddle welds.

C. Sidelap connections will be subject to inspection.

1. Inspector is to note and reject all sidelap spacing conditions which do not comply with the specified spacing.

2. Rejected sidelap locations shall be repaired by adding additional sidelap connectors.

3. The final Inspection Report shall note compliance with the specified spacing and quality of all sidelap connections.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor’s expense, will be performed to determine compliance of corrected work with specified requirements.

F. Test results and Inspection Reports shall be reported in writing to Architect, Contractor, and Authorities having jurisdiction within 48 hours of testing.

3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer’s written instructions.

B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION
SECTION 054000
COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Exterior structural and non-structural steel stud framing systems.
   2. Interior load-bearing framing systems.
   3. Cold-formed steel framing, including:
      a. Studs (STL STUD-1).
      b. Furring (STL FURG).
   4. Exterior wall and soffit sheathing (GYP SHTG-1).
   5. Engineering required to comply with specified performance requirements.
B. Related Sections:
   1. Section 092220 - Non-Structural Metal Framing: For interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.

1.2 ACTION SUBMITTALS
A. Product Data: For products not specifically listed in the specification, submit manufacturer’s technical datasheet indicating compliance with project requirements. For products listed in the specification, submit a list identifying products incorporated into the project. If multiple products of a given type are used, indicate portion of project for which each was used.
B. Shop Drawings: Submit in accordance with Section 013300.
   1. Shop drawings shall be signed and sealed by a qualified Professional Engineer.
   2. Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining Work.
C. Delegated Design Submittal and Shop Drawings: Where professional design services or certifications by a qualified Professional Engineer are specifically required of the Contractor by the Contract Documents, submit shop drawings submittal package with the delegated design submittal requirements in accordance with Section 013300 - Submittal Procedures.
D. Calculations: Contractor shall submit calculations in accordance with Section 013300 – Submittal Procedures.

1.3 INFORMATIONAL SUBMITTALS
A. Product Test Reports: For each product used on Project,
   1. Mill certificates or data indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
   2. Testing to be performed by a qualified independent testing agency.
B. Research Reports: For non-standard cold-formed steel framing, from ICC-ES.
1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed cold-formed metal framing similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code - Steel."
   2. AWS D1.3, "Structural Welding Code - Sheet Steel."

C. Inspection and Quality Control: Steel framing manufacturer shall provide qualified representative for periodic on-site review of fabrication and installation in accordance with manufacturer’s recommendations.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

PART 2 PRODUCTS

2.1 DESIGN CRITERIA AND PERFORMANCE REQUIREMENTS

A. Contractor shall engage a qualified Professional Engineer to provide delegated design services in accordance with Section 013300 – Submittal Procedures

B. Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200 Series.

C. Structural Performance: Design cold-formed metal framing and connections in accordance with applicable codes and standards, capable of withstanding project design loads, within limits and under conditions indicated, without excessive stress or deflection.
   1. Design Loads: Design and construct cold-formed metal framing, including anchorages, to withstand applied loads:
      b. Wind Loads: Provisions of ASCE 7-10 as shown on Construction Documents.
   2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
      a. Lateral Deflection of Studs Under Design Loading:
         1) Masonry Veneer Backup: Deflection not over L/720 of their unsupported height.
         2) Metal Panel Veneer Backup: Deflection not over L/360 of their unsupported height.
      b. Vertical Deflection of Joists Under Design Loading:
         1) Floor Members: Live Load deflection not over L/480 or Total Load Deflection not over L/360 of their unsupported length.
         2) Ceiling Joist Framing: Vertical deflection of 1/480 of the span for live loads and 1/360 for total loads of the span.
      c. Suspended metal stud framing systems shall support system dead loads, live loads, and wind loads with adequate attachment to main structure without distortion to the anchorage assembly.
   3. Building Movement:
      a. Structural Support Movement: Design system to accommodate anticipated vertical interstory differential live load deflection of 3/4 inch minimum upward and downward, in addition to anticipated thermal movement.
b. Sidesway Movement: System to accommodate anticipated interstory differential drift of H/400 in any horizontal direction.

c. Thermal Movement: System to provide for expansion and contraction within system components caused by cycling temperature change without causing detrimental effects to system or components.
   1) Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

4. Connections: Design connections to structure to support own weight and to withstand design loads without damage, deflection, overstressing, failure or other detrimental effects on connections or assembly components.
   a. Be responsible for design loads tributary to lateral and vertical connections to structural frame in accordance with the work of registered Structural Engineer.

5. Studs and track receiving anchors for other system components such as window and/or louver attachments shall be of adequate strength and gauge to support the loads of these attachments including prying, pullout, and twisting forces caused by eccentric loading conditions.

6. Bridging: all studs and joists shall have bridging line installed at a maximum of 4'-0" and 5'-0" o.c., respectively.

D. Fire-Test-Response Characteristics: Where metal framing is part of a fire-resistance-rated assembly, provide framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

2.2 COLD-FORMED STEEL FRAMING

A. Steel Sheet for Framing Components: ASTM A 1003, Structural Grade, Type H; with G90 protective zinc coating, and as follows:
   1. Grade: ST33H, unless indicated otherwise.

B. (STL STUD-1) Structural Steel Studs: ASTM C 955, C-shaped stud, punched, with stiffened flanges.
   1. Minimum Base-Metal Thickness: 0.0538 inch.
   2. Web Depth: As indicated, and not less than 6 inches.
   3. Flange Width: As indicated, and not less than 1-5/8 inches.

C. (STL STUD-2) Steel Studs for Interior Load-Bearing Wall: ASTM C 955, C-shaped stud, punched, with stiffened flanges.
   1. Minimum Base-Metal Thickness: 0.0538 inch.
   2. Web Depth and Flange Width: As indicated on Structural Drawings.

D. (STL JOIST-1) Structural Steel Stud Joist: ASTM C 955, C-shaped stud, punched, with stiffened flanges.
   1. Grade: ST50H.
   2. Minimum Base-Metal Thickness: 0.0538 inch.
   3. Web Depth: As indicated, and not less than 6 inches.
   4. Flange Width: As indicated, and not less than 1-5/8 inches.

   1. Minimum Base-Metal Thickness: 0.0428 inch.
   2. Depth: As shown.

   1. Minimum Base-Metal Thickness: 0.0329 inch.
   2. Depth: As shown.
G. Steel Track: ASTM C 955, U-shaped track, of web depths indicated, unpunched, with straight flanges, complying with , and as follows.
   1. Minimum Base-Metal Thickness: 0.0538 inch.
   2. Web Depth: As indicated, and not less than 6 inches.
   3. Flange Width: As indicated, and not less than 1-1/4 inches.

H. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads, and as follows.
   1. Minimum Uncoated-Steel Thickness: 0.0566 inch, unless otherwise indicated or necessary for engineering.
   2. Flange Width: Minimum of 2 inches vertical deflection of 1/2 inch. Provide greater width for greater deflections or use double deflection track. Studs and track receiving anchors for other system components such as window and louver attachments shall be of adequate strength and gauge to support the loads of these attachments including prying, pullout, and twisting forces caused by eccentric loading conditions.

I. Framing Accessories: Fabricate steel-framing accessories from steel sheet, ASTM A 1003, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   1. Supplementary framing.
   2. Bracing, bridging, and solid blocking.
   3. Web stiffeners.
   4. Anchor clips.
   5. End clips.
   6. Foundation clips.
   7. Gusset plates.
   8. Stud kickers, knee braces, and girts.
   9. Joist hangers and end closures.
  12. Backer strap at termination bar.

2.3 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36, zinc coated by hot-dip process according to ASTM A123.

B. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel hex-headed, headless, hooked, bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153, Class C.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to resist applied loads as determined in accordance with ACI 318 Appendix D. Expansion anchors shall have a ICC-ES report indicating compliance with the governing code.

D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

E. Mechanical Fasteners: Corrosion-resistant-coated, self-drilling, self-threading steel drill screws.
   1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.
2.4 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C1107, with fluid consistency and 30-minute working time.

C. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer’s standard widths to match width of bottom track or rim track members.

2.5 SHEATHING AND ACCESSORIES

A. (GYP SHTG-2) Glass-Mat-Faced Sheathing: ASTM C1177, Type X, 5/8 inch thick, high-moisture resistant board with water-resistant silicone or wax treated gypsum core and fiberglass reinforced faces manufactured in accordance with ASTM C1177 specially designed for exterior substrate.

1. Manufacturers and Products:
   c. USG: Securock Glass-Mat Sheathing.
   e. Temple-Inland.

B. Silicone Emulsion Sealant for Glass-Mat Gypsum Sheathing: Product complying with ASTM C834, compatible with sheathing tape and gypsum sheathing, recommended by sheathing and tape manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Product: Subject to compliance with requirements, provide "Elmer's Siliconized Acrylic Latex Caulk" by Borden, Inc.

C. Glass-Fiber Sheathing Tape for Glass-Mat Gypsum Sheathing: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads per inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing board and with a history of successful in-service use.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Perma-Tite Tape--PGM 207A; PermaGlas-Mesh, Inc.
   b. Quik-Tape; Quik-Tape, Inc.

D. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

1. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C 954.

2.6 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
   a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Grout bearing surfaces uniform and level to ensure full contact of bearing flanges or track webs on supporting concrete or masonry construction.

3.3 INSTALLATION, GENERAL
   A. Cold-formed metal framing may be shop- or field-fabricated for installation, or it may be field assembled.
   B. Install cold-formed steel framing according to ASTM C1007 and to manufacturer's written instructions unless more stringent requirements are indicated.
   C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
   1. Bolt or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
   D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
   1. Cut framing members by sawing or shearing; do not torch cut.
   2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths, unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

H. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer’s standard punched openings.

I. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 FRAMING INSTALLATION

A. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
   1. Install single deep-leg deflection tracks and anchor to building structure.
   2. Install vertical deflection clips to structure and to studs, one per stud at each floor and roof level.
   3. Install continuous top and bottom tracks sized to match studs.
   4. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
   5. Anchor Spacing: As shown on Shop Drawings.

B. Squarely seat studs against webs of top and bottom tracks. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
   1. Stud Spacing: As required to meeting loading requirements but not over 16 inches on center.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.

D. Align studs vertically where wall-framing continuity is interrupted by floor framing. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.

F. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
   1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings.
   2. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

G. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

H. Install horizontal bridging in stud system, spaced apart at dimension indicated on Shop Drawings. Fasten at each stud intersection.
   1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle.

I. Install steel sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.

J. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 JOIST INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
   1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
   2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.
   3. Joist Spacing: As shown.

C. Frame openings with built-up joist headers consisting of joist and joist track, or another combination of connected joists if indicated.

D. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated.
   1. Install web stiffeners to transfer axial loads of walls above.

E. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:
   1. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
   2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

F. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

G. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.6 GYPSUM SHEATHING INSTALLATION

A. General: Install gypsum sheathing to comply with GA-253 and manufacturer's written instructions.
   1. Coordinate sheathing installation with flashing and joint sealant installation so these materials are installed in the sequence and manner that prevent exterior moisture from passing through completed exterior wall assembly.
   2. Do not bridge building expansion joints with sheathing; cut and space edges to match spacing of structural support elements.
3. Cut boards at penetrations, edges, and other obstructions of the work; fit tightly against abutting construction, except provide a 3/8 inch setback where non-load-bearing construction abuts structural elements.
4. Apply fasteners so screw heads bear tightly against face of sheathing boards but do not cut into facing.

B. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.
   1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.

C. Vertical Installation: Install 48 inch wide gypsum sheathing boards vertically with vertical edges centered over flanges of steel studs. Abut ends and edges of each board with those of adjacent boards. Screw-attach boards at perimeter and within field of board to each steel stud at approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.

D. Seal or tape sheathing joints according to sheathing manufacturer's written instructions.
   1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
   2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

3.7 FIELD QUALITY CONTROL
A. Testing and Inspection: Owner will engage qualified special inspectors in accordance with Section 014533.
   1. Qualifications: The minimum category of special inspector required to perform services outlined below are noted by qualifications in parentheses. The definitions of the categories of special inspector are included in Section 014533.

B. Cold Formed Metal Framing Welds: Visually inspect 100% of welds for specified length, size and continuity in accordance with AWS D1.3 for metal less than 1/8 inch in thickness, for work designed as a structural element. (Technical I)

C. Testing agency shall conduct and interpret tests and state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom.

D. Provide access for testing agency to places where cold formed metal framing work is being fabricated or produced so that inspection and testing can be accomplished.

E. Testing agency may inspect cold formed metal framing before shipment; however, Owner's Representative reserves right at any time before final acceptance, to reject material not complying with requirements.

F. Correct deficiencies in work which inspections and test reports have indicated to be not in compliance with requirements when directed in writing by Architect or Owner.

3.8 REPAIRS AND PROTECTION
A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION
SECTION 054300
METAL SUPPORT ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Slotted metal channel framing assemblies (MSA).
   2. Support system engineering and fabrication.

1.2 ACTION SUBMITTALS
A. Product Data: For each system and component.
B. Shop Drawings:
   1. Indicate plan layout, sections, typical elevations, anchoring methods.
C. Delegated Design Submittal and Shop Drawings: Where professional design services or
certifications by a qualified Professional Engineer are specifically required of the Contractor by the
Contract Documents, submit shop drawings submittal package with the delegated design submittal
requirements in accordance with Section 013300 - Submittal Procedures.

1.3 INFORMATIONAL SUBMITTALS
A. Calculations: Upon request from the Architect/Engineer only, Contractor shall submit calculations in
accordance with Section 013300 - Submittal Procedures.

1.4 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Not less than 10 years' experience in the actual production of
specified products. Upon request, manufacturer shall submit proof of continuing quality assurance
program and shall demonstrate experience with projects of similar size and scope.
B. Manufacturer Quality Assurance Program: Upon request, manufacturer to submit mill test reports
for material furnished to assure that material meets specification criteria.
   1. Specifications for Design of Cold Formed Steel Structural Members: AISI.
   3. Welding: AWS

1.5 PROJECT CONDITIONS
A. Field Measurements: Installer shall take field measurements to assure that support system can be
installed without interference with structural framing, mechanical systems, plumbing, lighting, fire
suppression systems or other obstructions.
B. Coordination: Coordinate with architectural reflected ceiling plan and mechanical and electrical
Drawings. Area directly above support shall be free and clear of obstructions to ensure the support
system does not interfere with or dislocate other items. Coordinate with other contractors as
required.
PART 2 PRODUCTS

2.1 STRUCTURAL DESIGN REQUIREMENTS

A. Contractor shall engage a qualified Professional Engineer to provide delegated design services in accordance with Section 013300 - Submittal Procedures

B. Structural Performance:
   1. Design metal framing channels, connectors, and all accessories to support loads indicated in the Construction Documents.
   2. Design connectors to transfer loads from metal support assemblies to supporting members.

2.2 PRODUCTS AND MANUFACTURERS

A. Source Limitations: Provide complete support system, including framing members, hangers, fittings and hardware from single source from single manufacturer.

B. Products and Manufacturers: Provide Basis of Design or equivalent products as approved by Architect by one of the following manufacturers:
   1. Cooper B-Line, Inc., a Division of Eaton
   2. Flex-Strut.
   5. Hilti USA.
   7. Unistrut Corporation.
   8. Wesanco, Inc..

C. Metal Support Assemblies: Shop- or field-fabricated assemblies consisting of strut type cold-formed metal box channels, continuous slotted channel framing, bolted metal framing channels and all associated fittings and hardware; in compliance with performance and material requirements of MFMA-4.

D. (MSA-1) Slotted Channel Framing: Cold-formed 12 ga. galvanized steel, ASTM A 653, structural steel, Grade 33, with G90 coating and finish coating.

E. (MSA-2 – Unistrut Grid) Back-To-Back Solid Channel Framing: Cold-formed 12 ga. galvanized steel, ASTM A 653, structural steel, Grade 33, with G90 coating and finish coating.
   3. Color: Black

F. (MSA-3) Slotted Channel Framing: Cold-formed 12 ga. galvanized steel, ASTM A 653, structural steel, Grade 33, with G90 coating and finish coating.

G. (MSA-4) Slotted Channel Framing: Cold-formed 12 ga. galvanized steel, ASTM A 653, structural steel, Grade 33, with G90 coating and finish coating.
   3. Color: Black
H. Fittings: Formed or stamped steel nuts, bolts, washers and other devices designed to fit into channel slot and prevent slipping along channel.
   3. Bolt & Nut Material: Regular hexagon-head bolts, ASTM A307 Grade A; hex nuts ASTM A563; and where indicated, flat washers.
   4. Plain Washers: Round carbon steel, ASME B 18.22.1
   5. Lock Washers: Helical, spring type, carbon steel, ASME B 18.21.1
J. Finishes:
   1. Concealed Framing Members: Electro-Deposition Acrylic Coating, ASTM B117 or Pre-galvanized per ASTM A653 G90.
   2. Concealed Fittings: Hot-dipped galvanized per ASTM A123 or A153.
   3. Exposed Framing Members: [Electro-Deposition Acrylic Coating, ASTM B117] [Special powdercoating finish as selected by Architect, black color.]
   4. Exposed Fittings: Finish to match exposed framing members.

2.3 INSTALLATION ACCESSORIES

A. Embedded Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.
B. Power-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
C. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
D. Expansion Anchors: Anchor bolt and sleeve assembly (carbon-steel components zinc-plated to comply with ASTM B633) with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E488, conducted by a qualified independent testing agency.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.
   1. Do not proceed until unsatisfactory conditions have been corrected.
B. Field Measurements: Take field measurements; report interferences with structural framing, mechanical systems, or other obstructions to Architect/Engineer and general contractor.

3.2 INSTALLATION

A. Install equipment support system and accessories in accordance with reviewed Shop Drawings and manufacturer's printed instructions.
B. Set system accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Tighten all connections to their recommended torque values.

C. Provide anchorage devices and fasteners for securing equipment support systems to in-place construction.
   1. Attach to structure by means of imbedded concrete inserts, through bolts or by direct attachment to structural framing.

3.3 INSTALLED WORK

A. Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to not less than 1-1/2 inches.

C. Protection: Protect installed work from damage and alteration for remainder of construction.

END OF SECTION
SECTION 05 50 00
METAL FABRICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B.

1.2 SUMMARY

A. This Section includes the following:

1. Steel framing and supports for ceiling-hung toilet compartments.
2. Steel framing and supports for operable partitions.
3. Steel framing and supports for countertops.
4. Steel framing and supports for mechanical and electrical equipment.
5. Steel framing and supports for applications where framing and supports are not specified in other Sections.
7. Loose bearing and leveling plates.
8. Metal ladders.
9. Bar grating

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

C. Related Sections include the following:

1. Division 03 Section “Cast-in-Place Concrete” for installing anchor bolts, steel pipe sleeves, wedge-type inserts and other items indicated to be cast into concrete.
2. Division 04 Section “Unit Masonry” for installing loose lintels, anchor bolts, and other items indicated to be built into unit masonry.
3. Division 05 Section “Structural Steel Framing.”
4. Division 05 Section “Metal Stairs.”
5. Division 05 Section “Pipe and Tube Railings.”
6. Division 05 Section “Decorative Metal Railings.”

1.3 DEFINITIONS

A. Action Submittals: Mandatory submittals by the Sub-Contractor which require action on the part of the General Contractor, Construction Manager and Design Professional.

2. Design Professional: Review, Stamp and Return to the General Contractor or Construction Manager.

B. Informational Submittals: Mandatory submittals by the Sub-Contractor to the General Contractor, Construction Manager and Design Professional which are not returned but kept by each for their project record.
1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

1.5 ACTION SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.
   1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
   2. Provide templates for anchors and bolts specified for installation under other Sections.

1.6 INFORMATIONAL SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product Data: For the following:
   1. Paint products.
   2. Grout.

C. Welding certificates.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
   2. Provide allowance for trimming and fitting at site.

1.9 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.3 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
B. Steel Tubing: ASTM A 500, cold-formed steel tubing.
C. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
D. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-3.
   1. Size of Channels: 1-5/8
   2. Depth of Channels: As required by field and framing conditions.
   4. Nominal thickness: As required by field and framing conditions.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
C. Anchor Bolts: ASTM F 1554, Grade 36.
   1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.
D. Lag Bolts: ASME B18.2.1.
E. Wood Screws: Flat head, ASME B18.6.1.
H. Undercut or Adhesive Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.
   1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
E. Non-shrink, Nonmetallic Grout: Factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
E. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.
G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
   1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-
METAL FABRICATION

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts if units are installed after concrete is placed.

C. Fabricate supports for ceiling-hung toilet compartments from continuous steel beams or channels of sizes indicated with attached bearing plates, anchors, and braces as indicated.

D. Fabricate supports for operable partitions from continuous steel beams of sizes indicated with attached bearing plates, anchors, and braces as indicated. Drill bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

E. Galvanize miscellaneous framing and supports where exposed to the elements such as the Building Exterior as well as interior locations which are humid or corrosive.

2.8 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches, unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls.

2.9 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.10 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates after fabrication
2.11 METAL LADDERS

A. General:
1. Comply with ANSI A14.3, unless otherwise indicated.
2. For elevator pit ladders, comply with ASME A17.1.
3. Space siderails 18 inches apart, unless otherwise indicated.
4. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted brackets, made from same metal as ladder.

B. Steel Ladders:
1. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
2. Rungs: 3/4-inch diameter steel bars.
3. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
4. Provide non-slip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
5. Galvanize exterior ladders and interior ladders, where indicated, including brackets and fasteners.

2.12 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

2.13 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
1. ASTM A 123/A 123M, for galvanizing steel and iron products.
2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do
not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
   1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
   1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING BEARING AND LEVELING PLATES


B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
   1. Use non-shrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use non-shrink, nonmetallic grout in exposed locations, unless otherwise indicated.
   2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to
comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
SECTION 055005
METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Miscellaneous metal, except structural steel framing as specified in Section 051200 and defined as structural steel in AISC "Code of Standard Practice":
      a. Steel framing and supports for ceiling-hung toilet compartments, partitions, overhead doors and grilles, countertops, mechanical and electrical equipment, and other applications where framing and supports are not specified in other Sections.
      b. Miscellaneous steel trim including steel angle corner guards, steel edgings, loading-dock edge angles, and support for elevator door sills.
      c. Loose bearing and leveling plates for applications where they are not specified in other Sections.
   2. Metal Fabrications:
      a. Ships’ ladder (MET FAB-1).
      b. Straight Ladders (MET FAB-2) and (MET FAB-3).
      c. Bollards (MET FAB-5).
      d. Catwalk (MET FAB-14).
      e. Lighting Support Rails (MET FAB-15).
      f. Shelf Angles.
   4. Surface preparation and priming for finishes on ferrous metal, performed in shop.
   5. Engineering required to comply with specified performance requirements.

1.2 ACTION SUBMITTALS
A. Shop Drawings: Indicate dimensions, description of materials and finishes; include plans, elevations, sections, and details of metal stairs and ladders and their connections and reactions to building structure. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections, and installation procedures, including specific requirements indicated.
   1. Construction details, sizes of metal sections, thickness of metals, profiles, attachments, dimensions and field joints, method of support from structure, and finishes.
   2. Work to be built-in or provided by other Sections.
B. Delegated Design Submittal and Shop Drawings: Where professional design services or certifications by a qualified Professional Engineer are specifically required of the Contractor by the Contract Documents, submit shop drawings submittal package with the delegated design submittal requirements in accordance with Section 013300 - Submittal Procedures.
C. Calculations: Upon request from the Architect/Engineer only, Contractor shall submit calculations in accordance with Section 013300 - Submittal Procedures.
1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Firm experienced in producing metal stairs similar to those indicated for this Project and with record of successful in-service performance, as well as sufficient production capacity to produce required units.
B. Installer Qualifications: Arrange for metal stairs specified in this Section to be fabricated and installed by same firm.
D. Mockup: Prior to commencing fabrication of final work, build mockup of (MET FAB-25) to demonstrate constructability and execution of fabrication.

1.5 HANDLING AND STORAGE

A. Load, unload, handle and store work in manner that will not bend, deform or otherwise damage metal. Store so metal and shop coats will not be subject to weather or moisture, store off ground and provide covering for metal in storage.

1.6 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, temples, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 PRODUCTS

2.1 STRUCTURAL PERFORMANCE REQUIREMENTS

A. Contractor shall engage a qualified Professional Engineer to provide delegated design services in accordance with Section 013300 - Submittal Procedures
B. Structural Performance of Ships’ Ladders: Provide metal stairs and ship’s ladders capable of withstanding following structural loads without exceeding allowable design working stress of materials involved, including anchors and connections. Apply each load to produce maximum stress in each component of metal stairs.
   1. Treads and Platforms of Metal Stairs: Capable of withstanding uniform live load of 100 lb/sq ft or concentrated load of 300 lbs. on area of 4 sq. in., whichever produces greater stress.
   2. Stair Framing: Capable of withstanding stresses resulting from loads specified above in addition to stresses resulting from railing system loads.
   3. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.
C. Structural Performance of Straight Ladders: Provide side rails and rungs capable of withstanding following structural loads without exceeding the allowable working stress of materials and connections.
1. Single concentrated live load of 250 lbf applied at point that will cause the maximum stress in the member being considered.
2. Distributed live load of 30 lbf per foot applied along the height of the ladder.

D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

2.2 MATERIALS AND ACCESSORIES

A. Materials, General:
   1. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel:
   1. Steel Pickets, Plates, Shapes and Bars: ASTM A36; square corners and edges.
   2. Bars: Hot-rolled, carbon steel complying with ASTM A 29, Grade 1010; square corners and edges.
   3. Steel Tubing: ASTM A500 or ASTM A 513; square corners and edges.
   4. Steel Pipe: ASTM A53, Type S, Grade A, standard weight and extra-strong as required, galvanized and plain.
   5. Galvanized Sheet Metal: ASTM A526 or A527, G-90 coating designation with both sides of metal prime painted.

C. Welding Materials: Applicable AWS D1.1, type required for materials being welded.

D. Fasteners: Provide zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required
   1. Bolts, Nuts and Washers: High strength steel hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
   2. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, load equal to 6 times load imposed when installed in unit masonry and equal to 4 times load imposed when installed in concrete, as determined by testing per ASTM E488, conducted by qualified independent testing agency.
   3. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329

E. Concrete Materials and Properties: Comply with requirements in Section 033000 - Cast-in-Place Concrete.

2.3 METAL FABRICATIONS AND ASSEMBLIES

A. (MET FAB-1) Ships Ladders: Fabricate steel ships ladders of open-type construction with channel or plate stringers, pipe and tube railings, and bar grating treads, unless otherwise indicated. Provide brackets and fittings for installation.
   1. Comply with ANSI A14.3, unless otherwise indicated.
   2. Angle of Inclination: 60 degree angle from floor.
   3. Treads 24 inches long and approximately 6 inches wide.
   4. Handrails: 1-1/2 inch diameter pipe or tube.
   5. Finish: Shop-applied primer.
B. (MET FAB-2) Interior Steel Ladder:
   1. Comply with ANSI A14.3, unless otherwise indicated.
   2. Height as indicated on Drawings.
   3. Siderails: Continuous, 3/8 by 2-1/2 inch steel flat bars, with eased edges. Space siderails 16 inches apart, unless otherwise indicated.
   4. Rungs: 3/4 inch diameter steel bars at 12 inches on center.
   5. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
   6. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
   7. Support each ladder at top and bottom, and not more than 60 inches o.c. with welded or bolted steel brackets.

C. (MET FAB-3) Exterior Steel Roof Ladder:
   1. Comply with ANSI A14.3, unless otherwise indicated.
   2. Height and profile as indicated on the Drawings.
   3. Siderails: Continuous, 3/8 by 2-1/2 inch steel flat bars, with eased edges, and curved over the top to provide support. Space siderails 16 inches apart, unless otherwise indicated.
   4. Rungs: 3/4 inch diameter steel bars at 12 inches (305 mm) on center.
   5. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
   6. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
   7. Support each ladder at top and bottom, and not more than 60 inches o.c. with welded or bolted steel brackets.
   8. Galvanize exterior roof ladders, including brackets and fasteners.
   10. Ladder Safety Cages: Provide safety cages for ladders over 20 feet, in accordance with OSHA requirements.
       a. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless-steel fasteners.
       b. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet o.c. Provide secondary intermediate hoops spaced not more than 48 inches o.c. between primary hoops.
       c. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless-steel fasteners, unless otherwise indicated.

D. (MET FAB-5) Bollards Imbedded in Concrete: Hot-dipped galvanized steel pipe, 6 inch dia., 7 feet long, concrete filled, crowned cap, prime paint finish only the exposed top 3'-6".
   1. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
   2. Fill bollards solidly with concrete, mounding top surface to shed water.

E. (MET FAB-14) Catwalk Assemblies:
   1. Welded, Banded, Galvanized Steel Bar Grating: ASTM A 36 or steel strip, ASTM A 1011 or ASTM A 1018. Configuration as shown on structural drawings.
b. Traffic Surface: Plain.
2. Framing: Galvanized steel framing as shown on Structural Drawings.
3. Railings: Galvanized steel pipe or tube, welded construction and welded connection to platform framing, as specified in Section 055200 - Metal Railings. Configurations and dimensions as shown on Drawings.
4. Finish: Shop-prime for paint (PT-3). Coordinate with Section 099000 - Painting.

1. Finish: Shop-prime for paint (PT-3). Coordinate with Section 099000 - Painting.

G. Shelf Angles and Relief Angles: Fabricate shelf angles and relief angles from steel angles of sizes indicated and for attachment to steel and concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.
3. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
4. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.
5. Finishes:
   a. Exterior Walls, Concealed: Galvanized.
   b. Exterior Walls, Exposed: Galvanized, high-performance coating (HPC).
   c. Interior: Shop-applied primer and field-painted (PT).

2.4 FABRICATION, GENERAL
A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed corners with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
   1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

J. Miscellaneous Framing and Supports: Fabricate from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   1. Fabricate units from slotted channel framing where indicated.
   2. Furnish inserts for units installed after concrete is placed.

2.5 FINISHING

A. Comply with NAAMM’S "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

B. Stainless Steel:
   1. Finish designations prefixed by AISI shall conform with the system established by the American Iron and Steel Institute for designating finishes for stainless steel sheet.
   2. Bright, Directional Polish: AISI No. 4 finish.

C. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
   1. Hot Dip Galvanizing for Shapes and Plates: ASTM A123, for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strips 0.0299 inch thick and heavier.
   2. Hot Dip Galvanizing for Bolts and Similar Threaded Fasteners: ASTM A153, for galvanizing steel and iron hardware.
   3. Galvanizing Touch-Up Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed products:
   1. Exterior (SSPC Zone 1B): SSPC SP 6/NACE No. 3, "Commercial Blast Cleaning."
   2. Interior (SSPC Zone 1A): SSPC SP 3, "Power Tool Cleaning."
   3. Do not apply primer to galvanized surfaces.

E. Shop-Applied Primer and Field-Applied High-Performance Coating (HPC): Coordinate with Section 099600 - High-Performance Coatings.

F. Shop-Applied Primer and Field-Applied Paint (PT) or Epoxy Paint (PTE): Coordinate with Section 099000 - Painting.
PART 3 EXECUTION

3.1 EXAMINATION
A. Examine areas and conditions under which miscellaneous metal items are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Provide setting drawings, diagrams, templates, instructions and directions for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

B. Provide anchorage devices and fasteners where necessary for securing miscellaneous metal items to in-place construction; including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.

C. Perform cutting, drilling and fitting required for installation of miscellaneous metal items. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.

D. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch up shop paint coat. Do not weld, cut or abrade surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

E. Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

F. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide minimum dry film thickness of 2 mils.

3.3 INSTALLATION OF METAL BAR GRATINGS
A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

END OF SECTION
SECTION 055100
METAL STAIRS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
1. Interior exit stair assemblies.
2. Engineering required to comply with specified performance requirements.

1.2 ACTION SUBMITTALS
A. Shop Drawings: Indicate dimensions, description of materials and finishes; include plans, elevations, sections, and details of metal stairs and ladders and their connections and reactions to building structure. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections, and installation procedures, including specific requirements indicated.
1. Construction details, sizes of metal sections, thickness of metals, profiles, attachments, dimensions and field joints, method of support from structure, and finishes.
2. Work to be built-in or provided by other Sections.
4. Delegated Design Submittal and Shop Drawings: Where professional design services or certifications by a qualified Professional Engineer are specifically required of the Contractor by the Contract Documents, submit shop drawings submittal package with the delegated design submittal requirements in accordance with Section 013300 - Submittal Procedures.
B. Calculations: Contractor shall submit calculations in accordance with Section 013300 - Submittal Procedures.

1.3 INFORMATIONAL SUBMITTALS
A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.4 QUALITY ASSURANCE
A. Fabricator Qualifications: Firm experienced in producing metal stairs similar to those indicated for this Project and with record of successful in-service performance, as well as sufficient production capacity to product required units.
B. Installer Qualifications: Arrange for metal stairs specified in this Section to be fabricated and installed by same firm.
1.5 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, temples, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 PRODUCTS

2.1 STRUCTURAL PERFORMANCE REQUIREMENTS

A. Contractor shall engage a qualified Professional Engineer to provide delegated design services in accordance with Section 013300 - Submittal Procedures

B. Structural Performance of Stairs: Provide metal stairs and ship’s ladders capable of withstanding following structural loads without exceeding allowable design working stress of materials involved, including anchors and connections. Apply each load to produce maximum stress in each component of metal stairs.
   1. Treads and Platforms of Metal Stairs: Capable of withstanding uniform live load of 100 lb/sq ft or concentrated load of 300 lbs. on area of 4 sq. in., whichever produces greater stress.
   2. Stair Framing: Capable of withstanding stresses resulting from loads specified above in addition to stresses resulting from railing system loads.
   3. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

2.2 METAL STAIRS

A. Metal Stair Assemblies: Provide complete systems including stringers, framing, stair treads, platforms, decks, landings, connections and other components necessary for the support and installation of fabricated assemblies.
   1. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Commercial Class, unless more stringent requirements are indicated.
   2. Stringers: Fabricate stringers of channels, as indicated. Provide closures for exposed ends of channel stringers.
      a. Weld stringers to headers; weld framing members to stringers and headers.
   3. Subplatforms: Construct platforms of steel plate or channel framing members as indicated on Drawings and as needed to comply with performance requirements.
   4. Steel pan treads, platforms and landings to be filled with concrete as indicated on Drawings.
   5. Fabrication of Stairs and Landings:
      a. Fabricate stairs with closed risers and treads of pan construction.
      b. Form treads and risers from sheet stock.
      c. Properly secure tread pans to stringers with clip angles welded in place.
      d. Form stringers of rolled steel channels as required to meet performance requirements. Weld fascia plates of minimum 14 gage thick sheet stock across channel toes, where applicable.
      e. Form landings of sheet stock. Reinforce underside of landings with angles, tees as required.
f. Fabricate stairs, landings and component connections to support live loads of minimum 100 lb./sq.ft. with deflection of stairs and landings not exceeding 1/360 of span when underside is to be finished with gypsum board and 1/240 of span when underside is not being finished.

2.3 METAL GRATING STAIRS

A. Metal Grating Stairs: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Industrial Class, unless more stringent requirements are indicated. See Drawings for dimensions, configurations and details.

1. Finish: Shop-primed.
2. Stair Framing: Fabricate steel stringers as indicated on Drawings, with welded connections to headers.
3. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."
   a. Fabricate treads and platforms from welded steel grating.
   b. Finish: Galvanized.
   c. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

2.4 SPIRAL STAIRS

A. Center Column: Steel pipe welded to baseplate for anchorage to floor structure. Brace column at upper floors by means of landings attached to column and floor structure unless otherwise indicated. Provide cap for column if top is exposed.

1. Treads: Steel-bar grating or formed metal plate, as shown; welded to hubs or center column.
2. Railings: Uniformly bent to spiral shape.
   a. Hand Rail: Steel pipe.
   b. Top Rail: Steel pipe.
   c. Balusters: Steel pipe.
   d. Intermediate Rails: Steel pipe same size as top rail.

2.5 MATERIALS

A. Materials, General:

1. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
2. Recycled Content of Ferrous Metals: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Steel:

1. Rolled-Steel Floor Plate: ASTM A 786 rolled from plate complying with ASTM A 36 or ASTM A 283, Grade C or D.
2. Sections, Plates, Sheet and Bars: Structural quality steel; ASTM A36 and ASTM A440 where high strength steel is required.
5. Steel Pipe: ASTM A53, Type S, Grade A, standard weight and extra-strong as required, galvanized and plain.
7. Galvanizing: ASTM A123, hot dip galvanizing, thickness Grade 55 unless otherwise indicated.

C. Welding Materials: Applicable AWS D1.1, type required for materials being welded.

D. Fasteners: Provide zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required

1. Bolts, Nuts and Washers: High strength steel hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

2. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, load equal to 6 times load imposed when installed in unit masonry and equal to 4 times load imposed when installed in concrete, as determined by testing per ASTM E488, conducted by qualified independent testing agency.

3. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329

E. Concrete Materials and Properties: Comply with requirements in Section 033000 - Cast-in-Place Concrete for normal-weight, ready-mixed concrete with minimum 28-day compressive strength of 3500 psi, unless higher strengths are indicated.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

J. Miscellaneous Framing and Supports: Fabricate from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   1. Fabricate units from slotted channel framing where indicated.
   2. Furnish inserts for units installed after concrete is placed.

2.7 FINISHING

A. Comply with NAAMM'S "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

B. Stainless Steel:
   1. Finish designations prefixed by AISI shall conform with the system established by the American Iron and Steel Institute for designating finishes for stainless steel sheet.
   2. Bright, Directional Polish: AISI No. 4 finish.

C. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
   1. Hot Dip Galvanizing for Shapes and Plates: ASTM A123, for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strips 0.0299 inch thick and heavier.
   2. Hot Dip Galvanizing for Bolts and Similar Threaded Fasteners: ASTM A153, for galvanizing steel and iron hardware.
   3. Galvanizing Touch-Up Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
   4. At railings to be hot-dipped galvanized after fabrication: Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed products:
   1. Exterior (SSPC Zone 1B): SSPC SP 6/NACE No. 3, "Commercial Blast Cleaning."
   2. Interior (SSPC Zone 1A): SSPC SP 3, "Power Tool Cleaning."
   3. Do not apply primer to galvanized surfaces.

E. Shop-Applied Primer and Field-Applied Paint (PT) or Epoxy Paint (PTE): Coordinate with Section 099000 - Painting.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which miscellaneous metal items are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
3.2 INSTALLATION

A. Provide setting drawings, diagrams, templates, instructions and directions for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

B. Provide anchorage devices and fasteners where necessary for securing miscellaneous metal items to in-place construction; including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.

C. Perform cutting, drilling and fitting required for installation of miscellaneous metal items. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.

D. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch up shop paint coat. Do not weld, cut or abrade surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

E. Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

F. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide minimum dry film thickness of 2 mils.

3.3 INSTALLING METAL PAN STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

G. Place and finish concrete fill for treads and platforms to comply with Section 033000 "Cast-in-Place Concrete."
   1. Install abrasive nosings with anchors fully embedded in concrete. Center nosings on tread width.
H. Install precast concrete treads with adhesive supplied by manufacturer.

END OF SECTION
SECTION 055200  
METAL RAILINGS

PART 1 GENERAL

1.1 SUMMARY
   A. Section Includes: Guard rails and handrails for exit stair assemblies (MET RAIL).

1.2 COORDINATION
   A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
   B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
   C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.3 ACTION SUBMITTALS
   A. Product Data: For the following:
      1. Manufacturer's product lines of mechanically connected railings.
      2. Railing brackets.
   B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   C. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS
   A. Welding certificates.
   B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE
   A. Welding Qualifications: Qualify procedures and personnel according to the following:
      1. AWS D1.1, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.7 FIELD CONDITIONS
   A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.
PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance of Handrails and Railings: Provide handrails and railings capable of withstanding following structural loads without exceeding allowable design working stress of materials for handrails, railings, anchors, and connections:
   1. Top Rail of Guards: Capable of withstanding following loads applied as indicated:
      a. Concentrated load of 200 lbf applied at any point and in any direction.
      b. Linear load of 50 plf applied in any direction, not concurrent with above load.
   2. Handrails Not Serving as Top Rails: Capable of withstanding following loads applied as indicated:
      a. Concentrated load of 200 lbf applied at any point and in any direction.
      b. Linear load of 50 plf applied in any direction, not concurrent with above load.

2.2 STEEL HANDRAILS

A. Configurations: As indicated on Drawings and as follows:
   1. MET RAIL-1: Exit stair handrail, steel pipe, PT-11 finish
   2. MET RAIL-2: Exit stair guardrail, steel tube, PT-11 finish
   3. MET RAIL-3: Wall-mounted steel pipe handrail, PT-11 finish
   4. MET RAIL-6: Under-stair barrier rail; steel bar, PT-11 finish
   5. MET RAIL-7: Gate, self-closing, steel bar, PT-11 finish

B. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

C. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

D. Tubing: ASTM A 500 (cold formed) or ASTM A 513.

E. Pipe: ASTM A 53, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
   1. Provide galvanized finish for exterior installations and where indicated.

F. Plates, Shapes, and Bars: ASTM A 36.

G. Cast Iron: Either gray iron, ASTM A 48, or malleable iron, ASTM A 47, unless otherwise indicated.

2.3 AUXILLIARY MATERIALS

A. Fasteners for Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 for zinc coating.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Post-Installed Anchors: Capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
   1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

D. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

F. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

2.4 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove flux immediately.
   4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. Form Changes in Direction as Follows: As detailed.

J. Close exposed ends of railing members with prefabricated end fittings.

K. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

L. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

M. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.5 FINISHING

A. Comply with NAAMM’S "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed products:
   1. Exterior (SSPC Zone 1B): SSPC SP 6/NACE No. 3, "Commercial Blast Cleaning."
   2. Interior (SSPC Zone 1A): SSPC SP 3, "Power Tool Cleaning."
   3. Do not apply primer to galvanized surfaces.

C. Shop-Applied Primer and Field-Applied High-Performance Coating (HPC): Coordinate with Section 099600 - High-Performance Coatings.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Examine areas and conditions under which miscellaneous metal items are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Provide setting drawings, diagrams, templates, instructions and directions for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.
   B. Provide anchorage devices and fasteners where necessary for securing miscellaneous metal items to in-place construction; including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.
   C. Perform cutting, drilling and fitting required for installation of miscellaneous metal items. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.
   D. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch up shop paint coat. Do not weld, cut or abrade surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
   E. Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.
   F. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide minimum dry film thickness of 2 mils.

3.3 PROTECTION
   A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION
SECTION 057000
ORNAMENTAL METAL

1.1 SUMMARY
A. Section Includes: Decorative metal fabrications (ORN MET).

1.2 COORDINATION
A. Coordinate installation of anchorages for ornamental metal.
   1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
   2. Deliver such items to Project site in time for installation.
B. Coordinate work directly with other trades as necessary to insure proper fitting, joining to or clearance of their work.
   1. Furnish or exchange shop drawings and resolve required dimensions and details.
   2. Ship work to others as necessary and pay cost of such shipping.

1.3 ACTION SUBMITTALS
A. Shop Drawings:
   1. Indicate component details, materials, finishes, connecting, and joining methods, and relationship to adjoining work.
   2. Include plans, elevations, sections, and details of screen panels and accessories:
   3. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories. Provide graphic elements and layout for each sign.
B. Samples: Submit samples of each ORN MET material and finish.

1.4 QUALITY ASSURANCE
A. Fabricator and Installer Qualifications: Fabricators and Installers that are well-established and experienced fabricator and installer, acceptable to Owner and Architect, employing skilled workers to custom-fabricate and install Work similar to that required for this Project, whose Work meets or exceeds quality requirements specified, and whose completed Work has a record of successful in-service performance.
B. Welding Qualifications: Qualify procedures and personnel according to applicable requirements of AWS D1.
C. Mockups and Fabrication Samples: Build mockups to verify selections made under Sample submittals to demonstrate aesthetic effects and to set quality standards for fabrication and installation.
   1. Fabricate and install mockup of assembly using materials indicated for the completed Work.
   2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
   3. Demonstrate the proposed range of aesthetic effects and workmanship, installation and finishes.
   4. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
      a. Allow seven days for initial review and each re-review of each mockup.
   5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
D. Pre-Fabrication and Pre-Installation Conference: Prior to commence of fabrication, conduct a conference to ensure understanding of Construction Documents, design intent, installation, and coordination of Work by multiple subcontractors.

1. Attendees: Contractor, Architect, installers, fabricators, and manufacturer’s representatives who are involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow.

2. Suggested Agenda Items:
   a. Contract Documents comprehension; design intent; alternates; related RFI's.
   b. Fabricator's and Manufacturer's written recommendations; materials options; required performance results.
   c. Submittals; shop drawings; samples; mockups.
   d. Delineation of responsibilities for deferred design, fabrication and installation; coordination with other Work.
   e. Installation procedures; possible conflicts; compatibility issues.
   f. Delivery of materials and fabrications ready for installation; scheduling of deliveries; space and access limitations; protection of adjacent Work.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

B. Deliver and store cast-metal products in wooden crates surrounded by enough packing material to ensure that products are not cracked or otherwise damaged.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 WARRANTY

A. Warranty: Fabricator and installer agree to repair or replace components of ornamental metal assemblies that do not comply with requirements or that fail in materials or installation quality within specified warranty period.

1. Failures including but not limited to the following:
   a. Deterioration resulting from U.V. and weather exposure.
   b. Structural failures including rupturing, cracking, or puncturing.
   c. Deterioration of materials beyond normal weathering.

2. Provide warranty covering panel fabrication defects and loss of specified physical and performance properties, when panels are installed in accordance with manufacturer’s requirements.

3. Provide warranty covering cost of panel removal and installation of replacement panels.

4. Warranty Period: 10 years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 10 years from date of Substantial Completion.
PART 1 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. General: Provide ornamental metalwork composed of metals of forms and types which comply with requirements of referenced standards and which are free from surface blemishes where exposed to view in finished unit.

1. Exposed to view surfaces exhibiting pitting, seam marks, roller marks, oil canning, stains, discolorations or other imperfections on finished units are not acceptable.

B. Refer to Drawings for configurations.

C. Not Permitted: Vibration harmonics; noises caused by movement of components; vibration transmitted to other building elements; loosening, weakening, or fracturing of attachments or components of system.

1. Testing of the mock-up in a qualified acoustic testing laboratory may be conducted at the Owner’s discretion.


2.2 FABRICATIONS

A. (ORN MET-2) Radiator Cover: Manufactured steel radiator cover with perforated steel screen; provide wall mounting hardware and leveling feet.


2. Finish: Custom finish as selected by Architect.

B. (ORN MET-3) Flush Formed Steel Panel with Blackened Finish: Custom-fabricated, flush formed panels with return at walls & ceilings, as shown on Drawings; protective clear coating w/matte sheen; adhered or concealed fastening.

1. Panel Configuration:
   a. Profile: Flush
   b. Depth: 1 inch, unless shown otherwise.
   c. Sizes: As indicated on Drawings.

2. Steel Sheet: 0.030-inch (1/32-inch, 22 ga.), ASTM A 36.

   a. Clear Coating: As recommended by fabricator to be compatible with blackened finish, for the purpose of protecting finish from rubbing off when contacted.

4. Coordinate with Section 064000 - Architectural Woodwork for WD FAB-1 sliding pocket doors with ORN MET-3 facing.

C. (ORN MET-4) Expanded Metal Ceiling Panels: Formed expanded steel panels with return.

1. Panel Depth: As Shown.

2. Expanded Steel Sheet:
   a. Manufacturer: Amico.
   b. Style: 1/4" - #18.
   c. Minimum Sheet Thickness: 0.42".
   d. Openings:
      1) SWO: 0.110"
      2) LWO: 0.718"

3. Finish: Provide one of the following, in color to match PT-3:
   a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
b. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm). Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

4. Backer Panel: Medium-density fiberboard (MDF), ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde, with Class B or Class A Flame Spread Rating; thickness as shown.

D. (ORN MET-5) Wall Base: Steel plate or steel angle wall bas as shown on Drawings; welds ground smooth; painted finish to match PT-11.
   1. Steel Plates, Shapes and Bars: ASTM A36; square corners and edges.

E. (ORN MET-6) Formed Expanded Metal Panels:
   1. Panel Depth: As Shown.
   2. Expanded Steel Sheet:
      a. Manufacturer: Amico.
      b. Style: 1/4" - #18.
      c. Minimum Sheet Thickness: 0.42".
      d. Openings:
         1) SWO: 0.110"
         2) LWO: 0.718"
   3. Finish: Provide one of the following, in color to match PT-3:
      a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
      b. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm). Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

2.3 ACCESSORIES
A. Fasteners: Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless otherwise indicated.
   1. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.
   2. Provide flat-head machine screws for exposed fasteners unless otherwise indicated.

B. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
   1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 unless otherwise indicated.

C. Structural Anchors: For applications indicated to comply with certain design loads, provide anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
   1. Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
   2. Stainless Steel Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

D. Sound-Deadening Materials:
3. Gaskets: As required to seal joints in decorative formed metal and to prevent vibration; as recommended by fabricator.

E. Welding Electrodes and Filler Metal: Type and alloy of filler metal and electrodes as recommended by producer of metal to be welded, complying with applicable AWS specifications, and as required for color match, strength and compatibility in fabricated items.

F. Nongaseous grout complying with CE CRD C621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this section.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 FABRICATION

A. General: Provide ornamental metalwork composed of metals of forms and types which comply with requirements of referenced standards and which are free from surface blemishes where exposed to view in finished unit.
   1. Exposed to view surfaces exhibiting pitting, seam marks, roller marks, oil-canning, stains, discolorations or other imperfections on finished units are not acceptable.
   2. Refer to Drawings for configurations.

B. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
   1. Verify dimensions on site prior to shop fabrication.

C. Form ornamental metalwork to required shapes and sizes, with true curves, and angles. Provide components in sizes and profiles indicated, but not less than required to comply with requirements indicated for structural performance.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

E. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

F. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.
   1. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.

G. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

H. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.

I. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
J. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.

K. Nonwelded Connections: Fabricate railing systems and handrails for interconnection of members by means of concealed mechanical fasteners and fittings unless otherwise indicated.
   1. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

L. Welded Connections: Comply with AWS for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded joints of welding flux, and dress on exposed and contact surfaces.
   1. Weld corners and seams continuously and in accordance with recommendations of AWS.
   2. Grind exposed welds smooth and flush, to match and blend with adjoining surface.
   3. Discoloration of finished surfaces is not acceptable.

M. Dissimilar Surfaces:
   1. Bituminous Paint: Coat metals in contact with concrete, masonry, or other dissimilar surfaces with bituminous paint.
   2. Primer: Prime metals in contact with dissimilar metals with primer.

N. Finish exposed surfaces to smooth, sharp, well-defined lines and arises.

O. Form panel miters and copes to be tight fitting, square and in true alignment. Close exposed corners and seams by forming procedures or by welding, brazing or soldering and grinding smooth and flush on exposed surfaces. For exposed metal finishes, use filler metals that will blend and match sheet metal being joined. Comply with recommendations of AWS and NAAMM for welding, brazing and soldering.

P. Consider clearances with adjacent materials and provide correct procedures for erection. Provide supports, anchoring devices, anchor bolts, screws, clips, seals and gaskets, and other accessories.

2.5 FINISHING

A. Comply with NAAMM'S "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed products:
   1. Interior (SSPC Zone 1A): SSPC SP 3, "Power Tool Cleaning."

C. Shop-Applied Primer and Field-Applied High-Performance Coating (HPC): Coordinate with Section 099600 - High-Performance Coatings.

D. Shop-Applied Primer and Field-Applied Paint (PT) or Epoxy Paint (PTE): Coordinate with Section 099000 - Painting.

PART 2 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative formed metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions and directions for installation of items having integral anchors which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.3 INSTALLATION

A. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.

B. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.

F. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
   1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

G. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

H. Field Brazing: Comply with requirements for brazing and for finishing brazed connections in "Fabrication, General" Article. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations.

I. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
   1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.4 INSTALLED WORK

A. Final Cleaning of Bronze: Apply second coat of microcrystalline wax at time of Substantial Completion.

B. Final Cleaning, Waxing, Polishing of Bronze: Wax and polish to high-gloss sheen.

C. Protect finishes of ornamental metalwork from damage during construction period by use of temporary protective coverings approved by ornamental metalwork fabricator. Remove protective covering at time of Substantial Completion.
D. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items which cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units as required.

END OF SECTION
SECTION 05 72 00
ORNAMENTAL RAILINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Custom ornamental handrail and guardrail assemblies (ORN RAIL).
   2. Exterior aluminum railing (ALR-1).
   3. Engineering required to comply with specified performance requirements.

1.2 ACTION SUBMITTALS

A. Product Data: Submit product data for each product used in ornamental metalwork, including finishing materials and methods.

B. Shop Drawings:
   1. Indicate design criteria and applied loads for which the ornamental stair systems have been designed.
   2. Clearly indicate magnitude and location of all forces transferred to the primary building structure by cold-formed metal framing system. Loads shall be provided as unfactored values determined in accordance with ASCE 7-10.
   3. Indicate fabrication and installation of ornamental metalwork, including plans, elevations and details of components and attachments to other units of work. Indicate materials, profiles of each ornamental metalwork member and fitting, joinery, finishes, fasteners, anchorages and accessory items.
   4. Include setting drawings, templates and directions for location and installation of items and anchor bolts and other anchorage devices to be installed as unit of work of other sections.
   5. Shop drawings shall be signed and sealed by the qualified Professional Engineer responsible for their preparation.
   6. Deferred-Design Submittal: Submit shop drawings to Authority Having Jurisdiction for approval prior to commencing with this work on-site.

C. Fabrication Samples: Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, and infill. Samples need not be full height. Prepare samples of metal of same alloy and gauge to be used for Work. Fabrication shall include the following components:
   1. All vertical and horizontal rails.
   2. Welded and brazed connections.
   3. Fittings and brackets.
   4. Infill panels.
   5. Informational Submittals

D. Installer's Certificate: Signed by manufacture certifying the welders comply with requirements specified under Quality Assurance article.

E. Calculations: Signed engineering calculations prepared by the qualified Professional Engineer shall be submitted upon written request from the Architect/Engineer. Calculations shall indicate structural integrity of members, anchors, fasteners and connections to building structure, in accordance with specified criteria.
1. Engineering Responsibility: Calculations shall be reviewed for stated design assumptions, general compliance to specified requirements, and forces imposed on structure. The accuracy of the design calculations shall be the sole responsibility of the Contractor’s Professional Engineer.

2. Submitted calculations that have not been requested by the Architect/Engineer shall be returned without review.

1.3 QUALITY ASSURANCE

A. Fabricator Qualifications: Firm experienced in successfully producing ornamental metalwork similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in Work.

B. Installer Qualifications: Arrange for installation of ornamental metalwork specified in this section by same firm that fabricated unit.

C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Minnesota and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of ornamental metal railings that are similar to those indicated for this Project in material, design, and extent.

D. Qualify welding processes and welding operators in accordance with the following:
   1. AWS D1.1 Structural Welding Code - Steel.
   2. AWS D1.6, "Structural Welding Code - Stainless Steel."
   3. Certify that each welder employed in unit of work of this section has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
   4. Testing for recertification is Contractor’s responsibility.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build full-height mockups, not less than 24 inches long; consisting of two posts, top rail, infill panels and anchorage components; for each of the following ORN RAIL configurations:
      a. ORN RAIL-3.
      b. ORN RAIL-6.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.5 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers’ written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not suit structural performance requirements.
PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Structural Performance of Handrails and Railings: Provide handrails and railings capable of withstanding the following structural loads without exceeding allowable design working stress of materials for railings, anchors, and connections:

2. Top Rail of Guards:
   a. Concentrated load of 200 lbf applied at any point and in any direction.
   b. Linear load of 50 plf applied in any direction, not concurrent with above load.

3. Handrails Not Serving as Top Rails:
   a. Concentrated load of 200 lbf applied at any point and in any direction.
   b. Linear load of 50 plf applied in any direction, not concurrent with above load.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

2.2 ORNAMENTAL RAILINGS

A. Dimensions and Configurations: As shown on Drawings and as described below.

B. (ORN RAIL-3) Wood Handrails: Solid hardwood (WD-1) handrail, 1-1/2 inch outside diameter, on continuous steel bar spline; attached with brackets.


C. (ORN RAIL-4) Handrail, Wall-Mounted:

1. Hand Rail: Steel pipe.

2. Brackets: Bent bar with wall insert.

3. Finish: Shop-primed for (PT) finish.

D. (ORN RAIL-6) Handrail, Floor-Mounted:

1. Hand Rail: Steel pipe.

2. Posts: Steel bar.


E. (ORN RAIL-7) Orchestra Pit Guardrail: Removable guardrail floor-mounted at edge of orchestra pit, with architectural wood work cladding.

1. Concealed Framing: Steel shapes as shown, welded connections except at detachable points.

2. Cladding: WD FAB-3 as specified in Section 064000 - Architectural Woodwork.


F. (ORN RAIL-8) Stage Lift Guardrail: Removable guardrail floor-mounted to stage lift platform.

1. Top Rail: Steel pipe.

2. Posts: Steel bar.


G. (ALR-1) Aluminum Railing:
1. Finish: Color-anodized, black color.

2.3 MATERIALS

A. Materials, General:
   1. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
   2. Recycled Content of Ferrous Metals: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Steel:
   1. Steel Pickets, Plates, Shapes and Bars: ASTM A36; square corners and edges.
   2. Bars: Hot-rolled, carbon steel complying with ASTM A 29, Grade 1010; square corners and edges.
   3. Steel Tubing: ASTM A500 or ASTM A 513; square corners and edges.
   4. Steel Pipe: ASTM A53, Type S, Grade A, standard weight and extra-strong as required, galvanized and plain.
   5. Perforated Metal Plate: Cold-rolled steel sheet, ASTM A 1008, or hot-rolled steel sheet, ASTM A 1011, commercial steel Type B.
      a. Thickness:
      b. Perforations: 1/4-inch holes 3/8 inch o.c. in staggered rows.

C. Aluminum: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
   1. Extruded Bars and Shapes, Tubing: ASTM B 221, Alloy 6063-T5/T52.
   3. Drawn Seamless Tubing: ASTM B 210, Alloy 6063-T832.

D. Hardwood for Railings: (WD-1) as specified in Section 064000 - Architectural Woodwork.

2.4 ACCESSORIES

A. Fasteners and Anchors: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
   1. Stainless-Steel Components: Type 304 stainless-steel fasteners.
   2. Uncoated Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed; Type 304 stainless-steel fasteners where exposed.
   4. Dissimilar Metals: Provide Type 304 stainless-steel fasteners where indicated and where dissimilar metals are connected. Where dissimilar metals are connected, provide neoprene spacer or washer for isolation.

B. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

D. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. At exterior locations, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.5 FINISHES

A. Shop-Applied Primer: Coordinate and comply with the following applicable specifications Sections for primer materials, surface preparation and application:
   1. Paint (PT) or Epoxy Paint (PTE): Section 099000 - Painting.
   2. High-Performance Coating (HPC): Section 099600 - High-Performance Coatings.

B. Powder-Coat Finish: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:
   1. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
   2. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
   3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils.
   4. Color: Custom color as selected by Architect.

C. Color Anodic Finish: AAMA 611, AA-M12C22A44/A42, Architectural Class I, 0.7 mil (0.018 mm) or thicker.

2.6 FABRICATION

A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
   1. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
   2. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
   3. Form work true to line and level with accurate angles and surfaces.

B. Connections: Fabricate railings with welded connections to greatest extent possible, and mechanical connections as necessary for fabrication and installation.
   1. Welded Connections: Comply with AWS for recommended practices in shop welding. Weld behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded joints of flux, and dress exposed and contact surfaces.
      a. Grind exposed welds smooth and flush, to match and blend with adjoining surface.
      b. Discoloration of finished surfaces is not acceptable.
   2. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
      a. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
      b. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
   3. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
C. Finishing: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise shown and specified.
   1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
   2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
   3. Fabricate with exposed surfaces smooth, square, and free of surface blemishes, including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness.
      a. Remove blemishes by filling, grinding, or by welding and grinding, prior to cleaning, treating, and shop priming.
      b. Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for Architecturally Exposed Structural Steel.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Examine gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION
   A. Fit exposed connections together to form tight, hairline joints.
   B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
   C. Provide necessary anchors, plates, angles, hangers and struts as required for connecting stairs to the structure.
   D. Ensure alignment with adjacent construction. Coordinate with related work to ensure no interruption in installation.
   E. Perform necessary cutting and altering for installation of work of other sections. Do not perform any other additional cutting without review of Architect.
   F. Field bolt and weld to match standard of shop bolting and welding. Hide bolts and screws whenever possible. Where not hidden, use flush countersunk fastenings, unless indicated otherwise. Make mechanically fastened joints flush hairline butted. Grind welds smooth and flush.

3.3 INSTALLED WORK
   A. Cleaning:
      1. Clean aluminum and stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.
      2. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.
      3. Clean wood rails by wiping with a damp cloth and then wiping dry.
B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099000 - Painting or Section 099600 - High Performance Coatings.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

D. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

E. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION
SECTION 061000
ROUGH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Concealed carpentry work not specified in other Sections and not used as exposed work, including:
   1. Miscellaneous wood framing and concealed wood blocking and nailers.
   2. Wood sheathing.
   5. Anchors nails, bolts, and screws.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.3 INFORMATIONAL SUBMITTALS
A. Certificates:
   1. Submit letter certifying that lumber is kiln-dried to 15 - 19 percent moisture content, well-seasoned, grade marked, trademarked and free from warp.
   2. Submit letter from treatment plant certifying that chemicals and process used and net amount of salts retained are in conformance with specified standards.
   3. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
      a. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
   4. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
      a. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
      b. Submit letter certifying that fire-retardant treatment materials comply with requirements herein stated and local authorities having jurisdiction and that treatment will not bleed through finished surfaces.

1.4 QUALITY ASSURANCE
A. Lumber Standard:
   1. Comply with U.S. Dept. of Commerce Product Standard PS 20, including moisture content and actual sizes related to indicated nominal sizes.
   2. Comply with Standard Grading Rules No. 16 for West Coast Lumber.
   3. Comply with American Softwood Lumber Standard and with application grading rules of inspection agencies certified by American Lumber Standard Committee’s (ALSC) Board of Review.
4. Comply with lumber producer’s inspection agency grading rules certified as conforming to “National Grading Rules for Dimension Lumber” established under Section 10 of PS 20 and local code standard.


C. Mat-Formed Particleboard: Comply with ANSI A208.1. Provide particleboard bearing NPA grade marking.

D. Lumber: Factory-mark each piece of lumber with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying agency, grade, species, moisture content at time of surfacing and mill.
   1. Seasoning: Kiln-dry lumber to 15 - 19 percent moisture content, well-seasoned, grade marked, trademarked and free from warp.

1.5 DELIVERY, STORAGE AND HANDLING

A. Inspect wood materials for conformance to specified grades, species, and treatment at time of delivery to Project site.
   1. Reject and return unsatisfactory wood materials.

B. Provide facilities for handling and storage of materials to prevent damage to edges, ends and surfaces.

C. Keep carpentry materials dry.
   1. Store lumber and plywood in stacks with provision for air circulation within stacks.
   2. Protect bottom of stacks against contact with damp surfaces. Protect exposed materials against weather.
   3. Stack materials minimum 12 inches off ground, or if on concrete slab-on-grade, minimum 1-1/2 inches, fully protected from weather.
   4. Provide for air circulation within and around stacks and under temporary coverings.

D. Place spacers between each bundle of pressure treated materials treated with waterborne chemicals to provide air circulation.

1.6 PROJECT CONDITIONS

A. Environmental Impact: Products containing following materials will not be permitted:
   1. Urea Formaldehyde.
   2. Chromium in wood pressure treatment products.
   3. Arsenic.

1.7 COORDINATION

A. Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit, show location of furring, nailers, blocking, grounds and similar supports to allow attachment of other work.
   1. Coordinate work directly with other subcontractors as necessary to insure proper fitting, joining or to clearances of other work. Obtain templates as required to insure proper fitting.
PART 2 PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
   3. Provide dressed lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 15 percent maximum, unless otherwise indicated.

2.2 LUMBER

A. Dimension Lumber: Finished 4 sides, 15 percent maximum moisture content. Mark lumber "S-DRY".
   1. Light Framing: Construction grade Douglas Fir or Southern Pine, appearance grades where exposed.
   2. Boards: Construction grade.

B. Miscellaneous Lumber: Lumber for support or attachment of other construction, including rooftop equipment curbs and support bases, cant strips, bucks, nailers, blocking, furring, grounds, stripping and similar members.
   1. Grade: No. 3 or standard grade.
   2. Moisture content of 19 percent maximum for lumber items not specified to have wood preservative treatment.

2.3 WOOD SHEATHING


C. (WD SHTG-3) Concealed Sheathing: APA EXT, Rated Structural 1, touch sanded, Exposure 1, 23/32 or 3/4 inch depending on availability, square edge, Douglas Fir.

D. (WD SHTG-4) Concealed Sheathing: APA, C-D touch-sanded plugged. Exposure 1, 1/2 inch, FRT, square edge, Douglas Fir.

E. (WD SHTG-5) Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde, with Class B or Class A Flame Spread Rating; 3/4-inch thick.

F. (WD SHTG-9): 3/4" plywood, FRT, PT finish

G. (WD SHTG-12) Pegboard: 1/4-inch tempered hardboard.

2.4 PRESERVATIVE PRESSURE TREATMENT

A. Preservative Pressure Treatment: Comply with AWPA Standard U1, Use Category (UC2).
   1. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
2. Preservative Chemicals: Alkaline Copper Quaternary (ACQ) or other waterborne preservative type as listed in Section 4 of AWPA Standards U1, excluding those that contain arsenic or chromium; and acceptable to authorities having jurisdiction.
   a. Field-Applied Treatment: Provide same preservative chemical type as used for factory treatment, or compatible with factory treatment, for application to field-cut surfaces of preservative-treated lumber.
3. Extent of Treatment: Wood nailers and blocking in contact with cementitious materials, and plywood at parapets, and as indicated on Drawings.

2.5 FIRE-RETARDANT TREATMENT AND TREATED MATERIALS
A. General: Provide materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
   1. Extent of Treatment: Treat all rough carpentry, unless otherwise indicated.
B. Fire- Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   1. Complete fabrication prior to treatment to minimize cutting and jointing after treatment.
   2. Coat surfaces cut after treatment with heavy brush coat of same fire-retardant chemical.
   3. After treatment: Material shall be dried to an average moisture content of 15 percent or less for plywood and 19 percent or less for other lumber.
   4. Do not use twisted, warped, bowed or otherwise damaged or defective pieces.
C. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency. Each piece to bear:
   1. UL FR-S rating (flame spread and smoke developed less than 25).
   2. Complying with extended 30-minute tunnel test, ASTM E84 or UL 723
   3. Meet interior Type A requirements in AWPA Standard C-20 for lumber and C-27 for plywood.
   4. And shall be registered for use as a wood preservative by the U.S. Environmental Protection Agency.

2.6 ROUGH HARDWARE, FASTENERS AND ANCHORAGE DEVICES
A. Extent: Provide rough hardware required, including nails, screws, bolts, lag screws, cinch anchors, toggle bolts, shot anchors and similar items.
B. General: Provide proper size and type for use intended and for materials to be fastened.
   1. Install adequate hardware to insure substantial and positive anchorage.
   2. Use galvanized for exterior locations and high humidity locations and treated wood, plain finish for other interior locations.
   3. Fasteners, hangers and bearing plates used on or in connection with treated wood shall comply with IBC 2304.9.
C. Nails: Conform to materials standards established under FS FF-N-105.
   1. At exterior work, use galvanized steel nails.
   2. Refer to IBC Nailing Schedule for quality and size.
D. Mechanical Fasteners for Wood Decking: Swaneze stainless steel decking screws.
2.7 TAPES, SEALANTS AND MISCELLANEOUS

A. Adhesive: As recommended by manufacturer of product to be applied for surface material to give permanent adhesion, with material remaining flat to back surface. Comply with local code standards.
   1. Comply with APA AFG-01 for adhesive for use with type of construction panel indicated.
   2. Exterior: Phenolic resin waterproof glue.
   3. Interior: Water-resistant casein and other adhesives suited for particular use.

B. Expansion Material: Dow Chemical Ethafoam. Use where expansion joint material is indicated and not installed under other sections.

C. Concealed Sealants: Polyisobutylene sealant

D. Soft Gasket or Urethane Insulation:
   1. Product: "Shok-Pak" flexible semi-closed cell urethane.
   2. Provide 1/2 inch thicker than joint where foam tape, foam gasket and urethane insulation is indicated and not provided under other sections.
   3. Location: At gaps between framing and other materials.

E. Sill Sealer Gaskets:
   1. Glass-fiber resilient insulation, fabricated in strip form for use as a sill sealer.
   2. Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

PART 3 EXECUTION

3.1 FURRING, STRIPPING, GROUNDS AND BACKING

A. Install plumb, level, true and square. Anchor substantially for permanent installation. Set and shim to straight edge so finish wall is true and straight.

B. Provide grounds and backing as shown or required. Blocking as required or shown on drawings for plumbing fixtures, brackets, drapery rods, window and door frames, built-in furniture and other woodwork, both interior and exterior.

C. Allow for finishes and shim out to form level surfaces. Verify ground sizes and locations before installation.

3.2 INSTALLATION OF SHEATHING


B. Place roof and wall sheathing with end joints staggered. Secure sheets over firm bearing.
   1. Maintain minimum 1/16 inch and maximum 1/8 inch spacing between joints on walls. Place perpendicular to framing members.

C. Comply with roofing manufacturer's requirements for sheathing attachments.

3.3 SITE TREATMENT OF WOOD MATERIALS

A. Comply with AWPA M4 for applying field treatment to field-cut surfaces of preservative-treated lumber.
   1. Apply preservative treatment in accordance with manufacturer's printed instructions.
   2. Allow preservative to dry prior to erecting members.
END OF SECTION
SECTION 064000
ARCHITECTURAL WOODWORK

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Prefinished wood materials (WD).
   3. Wood-Veneer-Faced Cabinetwork.
   5. Solid Surface Fabrications (SSF).
   8. Requirements for Fabrication and Installation.

1.2 ADMINISTRATIVE REQUIREMENTS
A. Coordination: Coordinate work directly with Work of other Sections as necessary to ensure proper fitting, joining or required clearances of other work.
   1. Exchange and coordinate shop drawings and templates.
   2. Coordinate fabrication schedule.
   3. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that cabinets can be supported and installed as indicated.

B. Veneer Selection Conference: Prior to Pre-Fabrication Conference, conduct conference at veneer supplier’s site at which veneer flitches are made available to Architect to select actual flitches to be used on Project for the purpose of establishing acceptable range of aesthetic qualities, identifying flitches of consistent appearance and designating groups of flitches for specific applications and locations on Project.
   1. Attendees: Veneer supplier, woodwork Fabricator and Installer, wood door Manufacturer, Contractor, Construction Manager and Architect.

1.3 ACTION SUBMITTALS
A. Product Data: For each material and product to complete Work, including; solid hardwood, panel and veneer wood products, core materials, high-pressure decorative laminate, solid-surfacing, fire-retardant-treated materials, cabinetwork and hardware, components for wood fabrications, accessories and finishing materials.

B. Shop Drawings: Indicate dimensions, descriptions of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, including specific requirements where indicated.
   1. Coordinated Shop Drawings: Coordinate Shop Drawings with shop drawings of other Sections of related Work.
   2. Indicate materials and wood species, component profiles, fastening, jointing, details, finishes and accessories.
   3. For Work to receive matched wood veneers, show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
4. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
5. Indicate special requirements for field assembly and installation, including field connection locations, required clearances and tolerances.
6. Indicate provisions for attachment of architectural woodwork and other components performed by others in the field.
7. Indicate locations of plumbing and electrical service field conditions.

C. Samples: Submit full-size units or Samples of sizes indicated, prepared from same material to be used for the Work, with shop-applied transparent finish, that show full range of color and texture variations expected.
   1. Hardwood with Transparent Finish (WD-1): Submit set of at least three units exhibiting approximate limits of variations in color, pattern, texture, or other characteristics inherent in material or product. Apply finish to all faces and edges.
      a. Solid Hardwood with: 3” wide by 12” long,
      b. Hardwood Veneer: 12” by 12”, representative of and selected from actual flitches to be used for Project.
   2. Hardwood Veneered Panels with Transparent Finish for (WD FAB-1,4,5,6,8): 48 inches by 48 inches, with veneers representative of and selected from actual flitches to be used for Project. Include at least one face-veneer seam and finish as specified.
   3. Other Wood and Surfacing Samples: Submit 12 by 12 inch sample for each type, color and finish, with one edge treatment or profile as specified.
      a. (WD-5) Woodwork with Opaque Finish.
      b. (PLAM) Plastic Laminates .
      c. (SSF) Solid Surfacing.
   4. Cabinet Unit Samples: Units may be used as part of work if approved.
      a. Base cabinet with door, drawer, countertop and hardware.
      b. Wall-hung upper cabinet with door and shelf.
   5. Accessories and Hardware: Submit samples of hardware, accessories, and components of wood fabrications and casework.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Fabricator and Installer.
B. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.
C. Site Conditions Reports: Relative humidity and temperature readings taken before, during and after installation. Include readings taken in areas where woodwork is stored on site prior to installation.

1.5 QUALITY ASSURANCE
A. Fabricator and Installer Qualifications:
   1. Fabricator Qualifications: A well-established and experienced fabricator, acceptable to Owner and Architect, employing skilled workers to custom-fabricate millwork, casework and other architectural woodwork similar to that required for this Project, whose Work meets or exceeds quality requirements of specified NAAWS Grade, and whose completed Work has a record of successful in-service performance.
   2. Installer Qualifications: A well-established installer with experience installing millwork, casework, finish carpentry work, and other custom-fabricated woodwork similar to that required for this Project, whose Work meets or exceeds quality requirements of specified NAAWS Grade, and whose completed Work has a record of successful in-service performance.
3. Architect reserves the right to reject woodwork fabricator if it is Architect's opinion that previous performance by fabricator has been unsatisfactory, or if any of the following will not result in required quality within time required for completion:
   a. Shop capacity.
   b. Experience of workers.
   c. Equipment or supply of material.
   d. Previous performance by fabricator has been unsatisfactory.

B. Welding Qualifications: Qualify procedures and personnel in accordance with American Welding Society’s AWS D1 “Structural Welding Code.”

1.6 MOCKUPS
A. Mockups: Provide the following mockups as described below and as directed by Architect. See Section 014339 - Mockups for more information
   1. (WD FAB-1) Sliding Pocket Doors
   2. (WD FAB-3) Flush Wood Panels
   3. (WD FAB-4) Articulated Wood Panels
   4. (WD FAB-6) Proscenium Grille
   5. (WD FAB-7) Valade Grille
   6. (WD FAB-8) Diffusive Panels

1.7 SITE CONDITIONS
A. Delivery, Handling and Storage: Protect woodwork items from damage, dust and dirt. Do not deliver, receive, store or install woodwork materials until storage and installation areas are conditioned in accordance with requirements and recommendations of NAAWS.

B. Environmental Requirements: Use permanent HVAC system or provide temporary systems and controls to establish and maintain site conditions complying with specified requirements.
   1. Do not deliver, receive, store or install architectural woodwork until building is enclosed, wet work is complete, and temporary or permanent HVAC systems are operating in areas where woodwork is stored and installed, and are maintaining temperature and relative humidity at occupancy levels and within the following ranges during the remainder of the construction phase:
      a. Temperature Range: Between 60 and 90 deg F.
      b. Relative Humidity Range: Between 45 and 55 percent.
   2. Fluctuation of Temperature and Relative Humidity Levels: Maintain operation and control of heating, cooling, humidity, ventilation, temporary barriers and similar facilities continuously on a 24-hour basis to avoid rapidly fluctuating ambient levels.
      a. Do not exceed 15 percent fluctuation over any portion of a 7-day period. Do not exceed 25 percent fluctuation over any portion of a 28-day period.
   3. Site Conditions Report: Monitor temperature and relative humidity in areas where woodwork is stored and installed at Project site. Measure and record temperature and relative humidity prior to delivery, throughout storage period and installation, and after installation until time of Substantial Completion. Report recorded values in accordance with Submittals requirements.

C. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 PRODUCTS

2.1 ARCHITECTURAL WOODWORK, GENERAL

A. Quality Standards: Provide custom-fabricated architectural woodwork, casework, millwork and other assemblies that are fabricated and installed in accordance with the North American Architectural Woodwork Standards, Adopted and Published jointly by Architectural Woodwork Institute, Architectural Woodwork Manufacturer’s Association of Canada and Woodwork Institute - Current Edition (NAAWS).

1. Comply with requirements of specified NAAWS Grade except where more stringent requirements are indicated in the Contract Documents.

B. Acoustical Performance Requirements for Architectural Woodwork in Acoustically-Critical Spaces:

1. Comply with requirements of Section 018198 - Facility Acoustic Performance Requirements.
2. The following characteristics are not acceptable or permitted in final installed Work:
   a. Vibration harmonics, buzzing, rattling or squeaking.
   b. Noises caused by movement of components;
   c. Loosening, weakening, or fracturing of system components or attachments.

2.2 WOOD MATERIALS

A. Wood Materials, General:

1. Provide specified wood and other materials recommended by fabricator and in compliance with specified NAAWS Grade.
2. Fire-Retardant-Treated Materials: Where fire-retardant-treated materials are indicated, use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Wood Moisture Content: 5 to 10 percent.
4. Provide wood products made with binder containing no urea formaldehyde,
5. Dimensions: As indicated on Drawings.
6. Sheathing Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
7. Miscellaneous Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.
8. Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber .
   a. Class B or Class A Flame Spread Rating: Vesta FR by Sierra Pine.
   b. Class C Flame Spread Rating: Arreis by Sierra Pine.
14. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

1. Source Limitations: The intent of this requirement is to ensure matching of wood species and finishes by providing solid wood and wood veneers of like species from a single source with resources to provide materials of consistent quality in appearance and physical properties, and by shop-finishing woodwork in single shop using one process for each finish type.
   a. Engage a qualified woodworking firm to assume undivided responsibility for finishing all WD-1 woodwork.
   b. Supply wood veneer facing materials and finishing for wood doors required to be matched with architectural woodwork. Coordinate with Section 081400 - Flush Wood Doors.

2. Shop-Applied Transparent Finish System: Provide wood materials with finish system as specified below and matching Architect’s sample.
   b. First Coat, Stain: Deep penetrating, low VOC, one-coat, UV stable stain.
      1) Product: Sansin Purity Interior Stain.
   c. Second and Third Coats, Build-Up: Deep penetrating, clear, low VOC, UV resistant finish.
      1) Product: Sansin Purity Interior Glacier Finish.
   d. Fourth Coat, Finish: Deep penetrating, clear, low VOC, UV and wear resistant finish.

3. Veneer Matching:
   b. Matching within Panel Face: Center-balance match.
   c. Panel-Matching Method: Blueprint-matched panels and components within each separate area.
   d. Vertical Panel-Matching Method: Continuous match; veneer leaves of upper panels are continuations of veneer leaves of lower panels. At wood panel transoms over wood doors, provide continuous match between door and transom (If applicable).

4. Solid Hardwood Trim on Wood Fabrications: Match trim for compatibility of grain and color to itself and with veneers.

   1. Prefinished: Spray-apply primer and finish coats in shop, defer only final touchup, cleaning, and polishing until after installation.

D. (WD-5) Wood Materials for Opaque Painted Finish: Natural Birch or Poplar, finished in shop or in field.
   1. Field-Finishing: Shop-apply primer compatible with finishing system in accordance with Section 099000 - Painting.
   2. Prefinished: Spray-apply primer and finish coats in shop, defer only final touchup, cleaning, and polishing until after installation.

2.3 COMPONENTS & ACCESSORIES

A. Steel Sub-Framing and Supports: Welded steel framing and bracing as shown on Structural Drawings and as specified in Section 055000 - Metal Fabrications.
   1. Grind welded joints smooth.
2. Finish: Shop-primed and painted, color as selected by Architect. Coordinate with Section 099000 - Painting.

B. Anchors and Accessories: Stainless steel eye-bolt anchors, washers and other fabrication and installation accessories as shown; or other types as required by design engineer and approved by Architect.

C. Fasteners:
   1. Flathead Hex Wood Screw, black.
   2. Stainless steel fasteners with resilient neoprene washer.

D. Installation Accessories: Provide assembly hardware as shown on Drawings, or as recommended by Fabricator and approved by Architect.
   1. Mechanical Fasteners and Anchors: Use material, type, size and finish required for each substrate for secure anchorage and as recommended by architectural woodwork fabricator and installer.
      a. Provide concealed anchors unless otherwise indicated.
      b. Provide metal expansion sleeves or expansion bolts for post-installed anchors.
      c. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls.

2. Adhesives: Do not use adhesives that contain urea formaldehyde. VOC Limits for Installation
   Use products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      a. Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, rubber, or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
      b. Wood Glues: 30 g/L.
      c. Multipurpose Construction Adhesives: 70 g/L.
      d. Contact Adhesive: 80 g/L.

2.4 WOOD FABRICATIONS

A. Architectural Woodwork Fabrications, General: Custom-fabricate, finish and install complete assemblies as indicated in Construction Documents and approved Submittals, including all components and accessories required for complete fabrication and installation. Coordinate with Work of other Sections as indicated and as required to complete the Work.
   2. Dimensions and Configurations: As specified below and as indicated on Drawings.
   3. Hardware and Accessories: Provide all assembly components, as indicated in approved Submittals, for complete installation and operability.

B. Configurations, Dimensions and Components: As indicated on Drawings and as described below:
   1. (WD FAB-1) Sliding Pocket Doors
   2. (WD FAB-3) Flush Wood Panels
   3. (WD FAB-4) Articulated Wood Panels
   4. (WD FAB-6) Proscenium Grille
   5. (WD FAB-7) Valade Grille
   6. (WD FAB-8) Diffusive Panels

C. Fabrication Adhesives: Type as recommended by woodwork fabricator and adhesive manufacturer for intended use. Do not use adhesives that contain urea formaldehyde.

D. Mounting Accessories:
   1. Provide concealed mounting as shown on Drawings.
2. Furring, Blocking, Shims, and Hanging Strips: Kiln dried to less than 15 percent moisture content.
3. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors.

E. Concealed Fasteners for Panels: Provide corrosion resistant stainless steel, Type 316, mechanical fasteners meeting panel manufacturer’s requirements for fasteners to be used with metal mounting frame.

F. Finish Carpentry: Prefabricated or field-built custom interior carpentry millwork complying with NAAWS Premium Grade for construction, finishes, installation, and other requirements.
1. (WDB-1) Wood Wall Base: Solid WD-1, in profile and dimensions as shown on Drawings.
2. (WDB-5) Wood Wall Base: Solid WD-5, in profile and dimensions as shown on Drawings.

2.5 CABINETS AND COUNTERTOPS
A. Wood Veneer-Faced Cabinets with Transparent Finish:
   2. Type of Construction: Frameless.
   3. Door and Drawer Front Style: Flush overlay.
   4. Exposed, Semi-Exposed and Non-Exposed Wood Components: WD-1 and WD-2, as indicated on Drawings. Comply with veneer matching requirements as indicated in approved Shop Drawings.
   6. Type of Construction: Frameless.
   7. Door and Drawer Front Style: Flush overlay.
   8. Exposed, Semi-Exposed and Non-Exposed Wood Components: WD-5, as indicated on Drawings.

B. Plastic-Laminate-Faced Cabinets:
   2. (PLAM) Basis of Design: Refer to Material Identification List.
   3. Type of Construction: Frameless.
   4. Door and Drawer Front Style: Flush overlay.
   5. Cabinet, Door, and Drawer Front Interface Style: Flush overlay.
   6. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.

C. Plastic-Laminate-Faced Countertops:
   2. (PLAM) Basis of Design: Refer to Material Identification List.
   3. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS; post forming grade (0.039” thick) High Pressure laminate counter top.
   4. Edge Treatment: Post-formed, matching laminate in color, pattern, and finish.

2.6 SOLID SURFACE FABRICATIONS
A. (SSF) Basis of Design: As indicated on Material Identification List.

B. Resinous Solid Surface: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1.

C. Quartz Agglomerate Solid Surface: Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with the "Physical Characteristics of Materials" Article of ANSI SS1.
D. Adhesives, Sealants and Sealers: Comply with manufacturer’s written instructions for adhesives, sealants and sealers. Do not use adhesives that contain urea formaldehyde.
   1. Sealant: Silicone sealant as recommended by panel manufacturer for application to substrate.
   2. Sealers: As recommended by panel manufacturer for application to substrate.
   3. VOC Limits for Installation Adhesives and Glues, and for Primers and Sealers: Use installation adhesives with VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   4. Fabrication: Prefabricate countertops in one piece with shop-fabricated edges. Comply with quartz agglomerate manufacturer’s written instructions for adhesives, sealers, fabrication, joining and finishing.

E. Fabrication: Fabricate countertops in shop to greatest degree possible, in one piece with shop-applied eased edges, and in accordance with the following requirements, unless otherwise shown on Drawings.
   1. Configurations: As shown.
   2. Backsplash: Standard single length solid surface pieces; longest length possible to minimize joints. Where indicated provide countertop with coved backsplash.
   3. Inside Corners: Square.
   4. Sinks: Install integral sink bowls in countertops in the shop.

2.7 WALL-MOUNTED SHELVES

A. Brackets for Wall-Mounted Countertops and Shelves:
   1. Provide mounting brackets as shown on Drawings, in size and weight capacity required for use.
      a. Coordinate with Sections 054000, 055000, 061000, 092216 and other applicable Sections for concealed backing, support and anchoring as shown on Drawings.
   2. Steel Supports for Lavatory and Workstations: Provide custom fabricated steel supports in compliance with Section 055000 - Metal Fabrications. Provide in sizes and shapes as shown on Drawings.
      a. Steel Tubing: ASTM A501 or ASTM A500.
      c. Finish: Prefinished or shop-primed for field finish.
   3. (BKT-1) Countertop Brackets: 5mm thick steel bar with 3/4 inch steel strut, holds 1000 lb. per pair, finish in epoxy coated finish in color as indicated or selected.
   4. (BKT-2) Workstation Brackets: 1/8 inch steel; 1-1/2 inch forms with multiple 1/4 inch mounting holes per side; reversible; color as selected by Architect from manufacturer’s standard colors.
      a. Sizes: As required by application.
      b. Capacity: 1,000 pounds minimum.

B. Adjustable Shelf Brackets and Standards: Heavy-duty, 12 ga. steel, zinc-plated.
   4. (B&S-1) Configuration: 3/4"t x 12"d PLAM shelf; painted steel HD brackets

2.8 CABINET HARDWARE AND ACCESSORIES

A. Hinges:
   1. (HDWR-H1): BHMA A156.9, B01361, fixed pin, five knuckle steel hinges, dull chrome, 2-3/4 inch by 0.095 thick.
   2. (HDWR-H2): BHMA A 156.9 B01602, concealed, all-metal hinges, 110 degree opening (unless otherwise noted) self-closing, 3-way adjustable
b. Provide 3 per leaf over 48 inches high, 2 per leaf elsewhere.

B. Door and Drawer Pulls:
1. (HDWR-P3): 106.74.913 by Hafele, aluminum, matte silver finish.

C. Drawer Slides: BHMA A156.9, cold rolled steel, zinc plated with positive stop and full extension.
Provide products with rolling steel balls, nylon rollers meeting or exceeding the following requirements, unless otherwise indicated:
1. (HDWR-S1): Minimum 75 lb. load rating, for use at drawers 16-inches wide or less.
2. (HDWR-S2): Minimum 100 lb. load rating, for use at drawers 24-inches wide or less.
3. (HDWR-S3): Minimum 150 lb. load rating, for use at drawers greater than 24-inches wide, at deep drawers, and drawers with file folder racks.

D. Door Locks: BHMA A156.11, E07121.

E. Drawer Locks: BHMA A156.11, E07041.

F. Shelf Rests, Typical: BHMA A156.9, B04013.

G. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.

H. Cable Passage Grommets: Provide cord grommets in sizes shown, and in color as selected by Architect.
1. (GROM-1) Plastic Grommet Liner and Cap: SG Series or EDP Series by Doug Mockett.
3. (GROM-3) Wood Grommet Cap, No Liner: WG Series by Doug Mockett, matching (WD-__).
5. (GROM-5) Type: TG Series by Doug Mockett; White 95 or Black 90, as selected.

I. Glass Lites for Cabinetwork Doors: (GL-1T) fully-tempered clear float glass; 1/4-inch thickness; ASTM C1036, Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), and heat-treated to comply with ASTM C1048, Kind FT (fully tempered); with ground and polished flat edges.

2.9 FABRICATION

A. General: Fabricate Work of this Section using materials and methods in accordance with specified NAAWS Grade, and in accordance with reviewed Shop Drawings.
1. Complete fabrication in shop, including component assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site.
2. Join and assemble work to provide durable, strong, rigid units that will not warp or rack during shipping and installation.
3. Disassemble components only as necessary for shipment and installation. Allow for easy handling and passage through building openings.
4. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
5. Woodwork in Spaces without Humidification Control: Fabricate Work as necessary to protect installed Work from moisture and damage due to movement and dimensional changes associated with fluctuating temperature and relative humidity levels during construction and after Substantial Completion.

B. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
C. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

D. Metal Framing and Supports:
   1. Welded Connections: Comply with AWS for recommended practices in shop welding. Weld behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded joints of flux, and dress exposed and contact surfaces.
   2. Non-Welded Connections: Fabricate for interconnection of members by means of mechanical fasteners and fittings unless otherwise indicated.

E. Shop Finishing: Pre-finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
   1. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural wood cabinets, as applicable to each unit of work.
   2. Pre-finish woodwork at shop, defer only final touchup, cleaning, and polishing until after installation. Finish all surfaces, faces and edges of woodwork. Back-prime concealed surfaces with two coats of sealer or primer.
   3. Backpriming: Apply two coats of sealer or primer, compatible with finish coats, to concealed surfaces. Concealed surfaces of plastic-laminate-clad paneling do not require backpriming when surfaced with plastic laminate.
   4. Primer Application on Steel Framing: Apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, “Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel,” for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Examination and Acceptance of Conditions: Before proceeding with installation, take field measurements, examine substrates, measure temperature and relative humidity and other conditions.
   1. Verify that mechanical and electrical items affecting this section are properly placed, complete, and have been inspected by Architect prior to commencement of installation.
   2. Proceed with installation only after unsatisfactory conditions have been corrected and after building temperature and relative humidity are within specified range. Proceeding with the Work indicates acceptance of surfaces and site conditions.

B. Material Moisture Content and Environmental Requirements: Install products at the time and under conditions that will ensure the best possible results and maintain conditions until Substantial Completion.
   1. Comply with recommendations of NAAWS.
   2. Conditioning: Before installation, condition wood materials and cabinets in accordance with specified site condition requirements.
      a. Do not install unconditioned wood materials and assemblies.
      b. Reject materials that are wet, moisture damaged or mold damaged.

C. Substrate: Before proceeding with installation, examine substrate to receive work for compliance with requirements for installation tolerances and other conditions affecting performance. Installer must approve substrate prior to installation.
D. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product.
   1. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication.
   2. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   3. Verify space requirements and dimensions of items shown diagrammatically on Drawings.

3.2 INSTALLATION

A. General: Install architectural woodwork in accordance with North American Architectural Woodwork Standards (NAAWS) and in accordance with approved Shop Drawings.
   1. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
   2. Install free from hammer or tool marks, open joints, slivers or other defects detrimental to appearance or performance.
   3. Set plumb, level, square and true to dimensions shown and required. Allow for finishes and proper clearances where necessary. Use concealed shims where required for alignment.
   4. Tolerances: Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining work with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
   5. Scribe and cut to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
   6. Coordinate with materials and systems in and adjacent to woodwork and provide cutouts for mechanical and electrical items that penetrate exposed surfaces of trim and rails.
   7. Shop-Fabricated Work: Before installing, examine shop-fabricated work for completion. Assemble shop fabricated work and complete fabrication at Project site to the extent that it was not completed in the shop. Backprime unfinished surfaces that are concealed when installed.
   8. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.

B. Anchorage: Adequately anchor, fasten and support members to form secure, substantial and accurate work and to hold required dimensions and prevent twist.
   1. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
   2. Provide blocking, attachment plates, anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work.
   3. Provide anchorage type required to accommodate expected movement of wood due to changes in relative humidity without permanent damage to the wood and other components.

C. Fitting: Fit exposed connections together to form hairline joints. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect as determined by Architect.
   1. Provide joints to accommodate expected movement and expansion of woodwork due to changes in relative humidity.

D. Finish Carpentry, Millwork, Wall Base, Trim:
   1. Anchor to blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing.
   2. Install with minimum number of joints possible, using full-length pieces to greatest extent possible.
   3. Miter corners, countersink nails, drill holes for nails in hardwood.
E. Architectural Wood Fabrications: Install woodwork assemblies in accordance with approved Shop Drawings.

F. Wood Panels: Anchor woodwork to supporting substrate with concealed panel-hanger clips and by blind nailing on backup strips, splined-connection strips, and similar associated trim and framing.
   1. Do not face nail exposed surfaces unless otherwise indicated.
   2. Face-Nailing: Install prefinished boards with butt joints, and use finishing nails for exposed work. Finished work shall be free of hammer marks or open joints.
      a. After installation of woodwork with exposed fasteners, fill exposed nail holes flush with matching filler, sand as needed and touch-up finishes.

G. Solid Surfacing: Install solid surfacing in accordance with approved Shop Drawings and solid surfacing Manufacturer's written instructions and recommendations.

H. Cabinetwork: Install cabinets in accordance with requirements of same NAAWS Grade as item was fabricated.
   1. Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
   2. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork. For shop finished items use filler matching finish of items being installed.
   3. Maintain veneer sequence matching of cabinets with transparent finish.

I. Countertops: Anchor securely to base units and other support systems as indicated.

J. Wall-Mounted Shelving and Work-Surfaces: Install standards, brackets and other supports according to manufacturer's written instructions. Fasten to framing members, wood sheathing, wood blocking or metal backing, or use toggle bolts or hollow wall anchors.

K. Finishes: Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.
   1. Apply specified finish coats including, back-priming, opaque paint, stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are applied in shop.
   2. Refer to Section 099000 - Painting for final finishing of installed architectural woodwork not indicated to be shop finished, and for related brackets and other Work exposed to view.

3.3 INSTALLED WORK

A. Damaged or Non-Compliant Woodwork: Remove and replace materials that are damaged or do not comply with requirements.
   1. Damaged woodwork may be repaired or refinished only when resulting repair work complies with requirements and shows no evidence of repair or refinishing, as determined by Architect.
   2. Remove and replace woodwork materials that are wet, moisture damaged, or mold damaged.
   3. Replace, at no additional cost to Owner, materials that are damaged or that cannot be cleaned to satisfaction of Owner.

B. Adjusting: Adjust movable components of cabinetwork and woodwork assemblies to operate safely, smoothly, easily, and quietly, free from binding, warp, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range, and without binding or damaging assembly components. Lubricate hardware and moving parts. Adjust joinery for uniform appearance.
C. Cleaning: Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period.
   1. Clean interior finish carpentry on exposed and semi-exposed surfaces.
   2. Restore damaged or soiled areas and touch up factory-applied finishes, if any.
   3. Clean cabinetwork, counters, shelves, hardware, fittings and fixtures.

D. Protection: Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
   1. Protect installed products from damage from moisture, dust, dirt and from effects of weather and changing site conditions, throughout construction.
   2. Comply with specified requirements for temperature and relative humidity. Continue to take readings and report until Substantial Completion.

E. Demonstration and Training: Instruct Owner's personnel to operate, adjust and maintain operable components of woodwork assemblies.

END OF SECTION
SECTION 071413

HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reinforced rubberized-asphalt waterproofing system (WP-1).
   2. Protection and drainage course, rigid insulation and flashing.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
   1. Detailed specification of construction and fabrication.
   2. Manufacturer's installation instructions, specifically written for this project including procedures and materials for flashing, splicing and bonding.

B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions.
   1. Coordinate and provide transition details specific to Project between other adjacent materials including, but not limited to, existing Bentonite/Butyl and other existing waterproofing systems.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample Warranties: For special warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, and/or licensed by waterproofing system manufacturer to install manufacturer's products and that is eligible to receive manufacturer's special warranty.

B. Pre-Installation Conference:
   1. Conduct conference at Project site.
   2. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet
flashing, installation procedures, testing and inspection procedures, and protection and repairs.

C. Coordination: Coordinate Work of this Section with Work of other Sections for construction of mockups and for construction of permanent assemblies as indicated in the Construction Documents.

1. Coordinate Work of different Sections that depend on each other for proper installation, connection, and operation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.

B. Remove and replace liquid materials that cannot be applied within their stated shelf life.

C. Protect stored materials from direct sunlight.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, or when temperature is below 0 deg F.

1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace waterproofing and sheet flashings that do not comply with requirements or that fail to remain watertight within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Special Installer's Warranty: Specified form signed by Installer, covering Work of this Section, for warranty period of two years.

1. Warranty includes removing and reinstalling protection board, drainage panels, and insulation.

PART 2 PRODUCTS

2.1 WATERPROOFING SYSTEM

A. Source Limitations: Provide components and accessories; including waterproofing membrane, sheet flashings, protection course, drainage course and insulation; by a single Manufacturer or as approved by Manufacturer for complete warranted waterproofing system.
B. Material Compatibility: Waterproofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by waterproofing manufacturer based on testing and field experience.

C. Performance Requirements: Installed waterproofing system shall withstand thermally induced movement and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Waterproofing system shall remain watertight.

D. (WP-1) Waterproofing System:

1. Surface Conditioner.
2. Waterproofing Membrane: Base coat of 90 mils thick hot fluid-applied rubberized asphalt; embedded reinforcing for 100 percent coverage, 60 mils embedded uncured neoprene sheet reinforcing at corners; coat of 90 mils hot fluid-applied rubberized asphalt.
3. Drainage Course: 1/4-inch thick HDPE with filter fabric.
4. Insulation: Extruded-polystyrene board.

E. Hot Fluid-Applied, Rubberized-Asphalt Waterproofing Membrane: Single component; 100 percent solids; hot fluid-applied, rubberized asphalt.

2. Other Products and Manufacturers:
   a. Ram Tough 250 by Barrett.
   b. CCW-500R by Carlisle Coatings and Waterproofing.
   c. 790-11 by Henry Company.
   d. Tremproof 6100 by Tremco.

F. Auxiliary Materials: Provide materials recommended by waterproofing manufacturer for intended use and compatible with waterproofing.

1. Primer: ASTM D 41, asphaltic primer,
2. Elastomeric Sheet: 50 mil minimum thickness, uncured neoprene sheet, as recommended by waterproofing system manufacturer.
3. Metal Termination Bars: Manufacturer’s standard, predrilled stainless-steel or aluminum termination bars; approximately 1 by 1/8 inch thick; with stainless-steel anchors.
4. Sealants and Accessories: Manufacturer’s recommended sealants and accessories.

G. Protection Course: Semi-rigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners, conforming to ASTM D 6506.

H. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve, laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm/ft..

I. (INSUL-1) Unfaced Wall Insulation Drainage Panels: As specified in Section 072100 - Thermal Insulation.
3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
2. Ensure substrate is clean and free of depressions, waves or projections and is properly sloped to drainage locations.
3. Ensure curbs, pipes, sleeves, ducts, and vents through substrate are solidly set.
4. Do not proceed until unsatisfactory conditions have been corrected.

B. Verify moisture content of substrate to ensure current moisture content is within membrane manufacturer's requirements.

1. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
2. Provide additional drying techniques or equipment to obtain compliance.

C. Bond Test: Apply a test patch of waterproofing membrane to the surface and check its adhesion, per manufacturer's recommendations.

3.2 SURFACE PREPARATION

A. Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.

B. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate according to ASTM D 4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces according to ASTM D 4258.

3.3 JOINTS, CRACKS, AND TERMINATIONS

A. Prepare and treat substrates to receive waterproofing membrane, including joints and cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.

1. Rout and fill joints and cracks in substrate. Before filling, remove dust and dirt according to ASTM D 4258.
2. Adhere strip of elastomeric sheet to substrate in a layer of hot rubberized asphalt. Extend elastomeric sheet a minimum of 6 inches on each side of moving joints and cracks or joints and
cracks exceeding 1/8 inch thick, and beyond deck drains and penetrations. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.

3. Embed strip of reinforcing fabric into a layer of hot rubberized asphalt. Extend reinforcing fabric a minimum of 6 inches on each side of nonmoving joints and cracks not exceeding 1/8 inch thick, and beyond roof drains and penetrations.

B. At expansion joints and discontinuous deck-to-wall or deck-to-deck joints, bridge joints with elastomeric sheet extended a minimum of 6 inches on each side of joints and adhere to substrates in a layer of hot rubberized asphalt. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.

3.4 FLASHING INSTALLATION

A. Install elastomeric sheets at terminations of waterproofing membrane according to manufacturer's written instructions.

B. Prime substrate with asphalt primer.

C. Install elastomeric sheet and adhere to substrates in a layer of hot rubberized asphalt.

D. Extend elastomeric sheet up walls or parapets a minimum of 8 inches above plaza-deck pavers and 6 inches onto deck to be waterproofed.

E. Install termination bars and mechanically fasten to top of elastomeric flashing sheet at terminations and perimeter of waterproofing.

3.5 MEMBRANE APPLICATION

A. Apply primer, at manufacturer's recommended rate, over prepared substrate and allow it to dry.

B. Heat and apply rubberized asphalt according to manufacturer's written instructions.

1. Heat rubberized asphalt in an oil- or air-jacketed melter with mechanical agitator specifically designed for heating rubberized asphalt.

C. Start application with manufacturer's authorized representative present.

D. Reinforced Membrane: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to a thickness of 90 mils; embed reinforcing fabric, overlapping sheets 2 inches; spread another 125-mil-thick layer to provide a uniform, reinforced, seamless membrane 215 mils thick.

E. Apply waterproofing over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.

F. Cover waterproofing with protection course with overlapped joints before membrane is subject to backfilling.

3.6 PROTECTION COURSE INSTALLATION

A. Install protection board over membrane as soon as system will allow.
B. Cover waterproofing with protection course with overlapped joints before membrane is subject to construction or foot traffic.

3.7 DRAINAGE PANEL INSTALLATION

A. After electronic membrane integrity tests, specified under Field Quality Control below, are completed, install drainage board over membrane and protection board.

B. Place and secure drainage composite with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use methods that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed drainage composite during subsequent construction.

3.8 INSULATION INSTALLATION

A. Install [one or more layers of board insulation to achieve required thickness] [and] [insulation drainage panels] over waterproofed surfaces. Cut and fit to within 3/4 inch of projections and penetrations.

B. On vertical surfaces, set insulation units into rubberized asphalt according to manufacturer's written instructions.

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Membrane manufacturer's technical representative shall provide following field services during installation.

1. Pre-form a pre-installation examination and acceptance of substrate and surface preparation for each stage. Issue report.
2. Be present at initial start-up for each process. Confirm application rates and techniques. Issue report.
3. Issue summary report at completion of installation indicating manufacturer's acceptance of installed system and warranty conditions.

B. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, waterproofing application, protection, and drainage components, and to furnish reports to Architect.

3.10 INSTALLED WORK

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Protect installed insulation from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.
END OF SECTION
SECTION 071700

BENTONITE WATERPROOFING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Bentonite and HDPE waterproofing system (WP-2).
   2. Bentonite waterproofing accessories.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, and installation instructions.
   2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.
B. Shop Drawings: Include installation details for waterproofing, penetrations, and interface with other work.
C. Samples: Submit sample of bentonite waterproofing panel in accordance with Section 013300.
   1. Waterproofing: 6 inches square.
   2. Protection Course: 6 inches square.

1.3 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of waterproofing material.
B. Preconstruction Test Reports: For water samples taken at Project site along with recommendations resulting from these tests.
C. Field quality-control reports.
D. Sample Warranty: For manufacturer's special warranty.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer, with a minimum of 2 years’ experience in installing bentonite clay waterproofing products
B. Pre-Installation Conference: Conduct conference at Project site. Review waterproofing requirements, including surface preparation, substrate condition and pretreatment, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.
C. Mockups: Build mockups to set quality standards for fabrication and installation.
   1. Build mockup of installation on typical vertical and horizontal surfaces, 10 sq. ft. in size.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
D. Preinstallation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials to Project site in manufacturer's original unopened and undamaged containers.
B. Store materials in a dry, well-ventilated space.
C. Remove and replace bentonite materials that have been prematurely exposed to moisture.

1.6 FIELD CONDITIONS
A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit bentonite waterproofing to be installed according to manufacturer's written instructions and warranty requirements.
   1. Do not apply waterproofing materials to surfaces where ice or frost is visible. Do not apply bentonite waterproofing materials in areas with standing water.
   2. Do not place bentonite clay products in panel or composite form on damp surfaces unless such practice is approved in writing by manufacturer.

1.7 WARRANTY
A. Special Warranty: Manufacturer and Contractor agree to provide labor and materials to repair or replace waterproofing components that do not comply with specified performance requirements or that fail in materials or workmanship within specified warranty period, and to provide such corrections at no cost to Owner and without disruption of Owner’s daily operations.
   1. Warrant that installed waterproofing system shall be free of defects including waterproofing failure resulting from substrate cracking up to 1/8 inch.
   2. Manufacturer's standard warranty covering materials.
   3. Applicator's standard warranty covering workmanship.
   4. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 WATERPROOFING SYSTEMS
A. Provide complete waterproofing system in accordance with waterproofing Manufacturer's recommendations and requirements for warranty.
B. Source Limitations: Provide system components and accessories by waterproofing Manufacturer or as approved by manufacturer, including bentonite clay granules, mastic, drainage composites, and other accessories.
C. Material Compatibility: Waterproofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by waterproofing manufacturer based on testing and field experience.
D. Performance Requirements: Installed waterproofing system shall withstand thermally induced movement and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Waterproofing system shall remain watertight.

2.2 COMPOSITE HDPE/BENTONITE WATERPROOFING
A. (WP-2) Provide one of the following as suited for application and Project conditions:
   1. Composite HDPE/Bentonite Membrane:
      a. Minimum 90-mil- thick membrane consisting of a 12-mil- thick, HDPE geomembrane liner bonded to a layer of bentonite clay granules 78 mils thick.
      c. Vapor Permeance: 0.030 perms according to ASTM E 96.
      d. Products and Manufacturers:
         1) Swelltite by CETCO.
         2) TegraTite by TegraSeal.
         3) Paraseal by Tremco.
2. Composite HDPE/Bentonite Membrane with Protective Facing:
   a. Minimum 170-mil-thick membrane consisting of HDPE geomembrane liner bonded to a layer of bentonite clay granules and with a spun polypropylene facing.
   c. Vapor Permeance: 0.031 perms according to ASTM E 96.
   d. Manufacturers and Products:
      1) TegraTite Plus by TegraSeal.
      2) Paraseal LG by Tremco.

2.3 INSTALLATION ACCESSORIES

A. Granular Bentonite: Sodium bentonite clay containing a minimum of 90 percent montmorillonite (hydrated aluminum silicate), with a minimum of 90 percent passing a No. 20 sieve.

B. Granular Bentonite Tubes: Manufacturer's standard 2-inch-diameter, water-soluble tube containing approximately 1.5 lb/ft. of bentonite; hermetically sealed; designed specifically for placing on wall footings at line of joint with exterior base of wall.

C. Bentonite Mastic: Trowelable consistency, bentonite compound, specifically formulated for application at joints and penetrations.

D. Termination Bar: Formed-stainless-steel bars with upper flange to receive sealant.

E. Sealants: As recommended in writing by waterproofing manufacturer. Comply with requirements specified in Section 079000 - Joint Protection.

F. Tapes: Waterproofing manufacturer's recommended tape for joints between sheets, membranes, or panels.

G. Adhesive: Water-based adhesive used to secure waterproofing to both vertical and horizontal surfaces.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations affecting performance of bentonite waterproofing.

B. Verify that substrate is complete and that work that will penetrate waterproofing is complete and rigidly installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate work in the vicinity of waterproofing to ensure proper conditions for installing the waterproofing system and to prevent damage to waterproofing after installation.

B. Formed Concrete Surfaces: Remove fins and projections. Fill voids, rock pockets, form-tie holes, and other defects with bentonite mastic or cement grout patching material according to manufacturer's written instructions.

C. Horizontal Concrete Surfaces: Remove debris, standing water, oily substances, mud, and similar substances that could impair the bonding ability of concrete or the effectiveness of waterproofing. Fill voids, cracks greater than 1/8 inch, honeycomb areas, and other defects with bentonite mastic or cement grout patching material according to manufacturer's written instructions.
D. Excavation Support and Protection System: If water is seeping, use plastic protection sheets or other suitable means to prevent wetting the bentonite waterproofing. Fill minor gaps and spaces 1/8 inch wide or wider with wood, metal, concrete, or other appropriate filling material. Cover or fill large voids and crevices with cement mortar according to manufacturer's written instructions.

3.3 INSTALLATION, GENERAL

A. Prepare substrates, voids, cracks, and cavities; and install waterproofing and accessories according to manufacturer's written instructions.

1. Before installing, verify the correct side of waterproofing that shall face substrate surface.
2. Apply granular bentonite around penetrations in horizontal surfaces and changes in plane according to manufacturer's details in preparation for bentonite tubes and mastic.
3. Apply bentonite tubes, bentonite mastic, or both at changes of plane, construction joints in substrate, projections, and penetrations.
4. Prime concrete substrates. Primer may be omitted on concrete surfaces that comply with manufacturer's written requirements for dryness, surface texture, and freedom from imperfections.

B. Apply bentonite tubes continuously on footing against base of wall to be waterproofed.

C. Protect waterproofing from damage and wetting before and during subsequent construction operations. Repair punctures, tears, and cuts.

D. Install protection course before backfilling or placing overburden when recommended in writing by waterproofing manufacturer.

E. Place and secure molded-sheet drainage panels according to manufacturer's written instructions. Use adhesives or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

3.4 COMPOSITE HDPE/BENTONITE MEMBRANE INSTALLATION (WP-2)

A. General: Install a continuous layer of waterproofing membrane with ends and edges lapped a minimum of 4 inches. Stagger end joints between membranes a minimum of 24 inches. Seal joints with permanent seam tape.

B. Below Structural Slabs-on-Grade: Apply waterproofing membrane with HDPE side down and staple ends and edges.

1. Install under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls, and extend a minimum of 8 inches up or beyond perimeter slab forms.
2. Protect waterproofing from damage caused by reinforcing bar supports with sharp edges.

C. Slabs: Starting at lowest point, install a continuous layer of waterproofing membrane, with ends and edges lapped a minimum of 2 inches.

D. Concrete Walls: Apply mastic around penetrations and form continuous 2-inch cant at intersection of footings and walls with mastic.

1. Starting at lowest point, install a layer of waterproofing membrane horizontally, extending a minimum of 6 inches onto the footing. Lap membrane ends and edges a minimum of 2 inches.
2. Secure membrane to wall with continuous adhesive or washer-headed fasteners, and tape terminations of membrane at grade.
3. Termination at Grade: Extend waterproofing membrane to finish grade as indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.
E. Excavation Support and Protection (Permanent Shoring): Cut, clean, and treat tiebacks and similar projections. Encase tieback heads, rods, nuts, and plates according to waterproofing manufacturer's written instructions for each configuration. If water is present, cover shoring and lagging with plastic protection sheets; remove plastic sheets before placing concrete.

1. Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped minimum of 4 inches and nailed to shoring.
2. Inspect and repair waterproofing membrane after reinforcing steel has been placed. Coordinate and control concrete placement to avoid damage to waterproofing.

3.5 FIELD QUALITY CONTROL
A. Inspection: Arrange for manufacturer's representative to inspect completed waterproofing installation before covering with other construction and provide written report that installation complies with manufacturer's written instructions.

1. Remove and replace applications of bentonite waterproofing where inspection indicates that it does not comply with specified requirements.

3.6 INSTALLED WORK
A. Protect installed waterproofing from precipitation or ground water until concrete pour is completed. Pour concrete as waterproofing installation is completed.

B. Protect waterproofing from damage by concrete pour or other causes. Repair damage areas prior to concrete pour.

END OF SECTION
SECTION 072100

THERMAL INSULATION

1.1 SUMMARY

A. Section Includes:

   1. Extruded-polystyrene board (INSUL-1).

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

   B. Protect plastic insulation as follows:

      1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
      2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
      3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 1 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.


B. INSUL-26: Mineral-fiber, semi-rigid board; RockWool CavityRock

C. INSUL-30: Polyurethane foam, spray-applied, closed-cell

2.2 EXTRUDED-POLYSTYRENE BOARD INSULATION

A. (INSUL-1) Extruded Polystyrene Board Drainage Panels (Below Grade): ASTM C 578, Type IV, 25-psi minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

1. Surface Burning Characteristics: Maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.
2. Products and Manufacturers:
   a. Styrofoam SE by Dow Chemical.
   b. Foamular 250 by Owens Corning.
   c. Certifoam by DiversiFoam Products.
   d. GreenGuard CM by Pactiv Building Products.

2.3 SEMI-RIGID MINERAL WOOL


1. Basis of Design: CavityRock by Roxul Inc..
2. Performance Requirements:
   a. Thermal Resistance, ASTM C518: R-value per inch at 75° F = 4.3 hr. ft². F/BTU.
   b. Moisture Absorption, ASTM C1104: 0.07 percent, maximum.
   d. Flame Spread Index, ASTM E84: 0, maximum.
   e. Smoke Developed Index, ASTM E84: 0, maximum.

2.4 SPRAY POLYURETHANE FOAM INSULATION

A. (INSUL-30) Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II.

1. Manufacturers:
   a. BASF Corporation.
   b. Dow Chemical Company.
   c. Henry Company.

2. Minimum density of 1.5 lb/cu. ft., thermal resistivity of 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F.
3. Fire Characteristics per ASTM E84:
   a. Maximum flame-spread of 75
   b. Maximum smoke-developed indices of 450
2.5 INSULATION FASTENERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Adhesively Attached, Spindle-Type Anchors:
   a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
   b. Eckel Industries of Canada Limited; Stic-Klip Type N Fasteners.
   c. Gemco; Spindle Type.

2. Adhesively Attached, Angle-Shaped, Spindle-Type Anchor:
   a. Gemco; 90-Degree Insulation Hangers.

3. Insulation-Retaining Washers:
   a. AGM Industries, Inc.; RC150.
   b. AGM Industries, Inc.; SC150.
   c. Gemco; Dome-Cap.
   d. Gemco; R-150.
   e. Gemco; S-150.

4. Insulation Standoff:
   a. Gemco; Clutch Clip.

5. Anchor Adhesives:
   a. AGM Industries, Inc.; TACTOO Adhesive.
   b. Eckel Industries of Canada Limited; Stic-Klip Type S Adhesive.
   c. Gemco; Tuff Bond Hanger Adhesive.

B. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:

1. Plate: Perforated galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.

2. Spindle: Copper-coated, low carbon steel, fully annealed, 0.105 inch (2.67 mm) in diameter, length to suit depth of insulation indicated.

C. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:

1. Angle: Formed from 0.030-inch- (0.762-mm-) thick, perforated, galvanized carbon-steel sheet with each leg 2 inches (50 mm) square.

2. Spindle: Copper-coated, low carbon steel, fully annealed, 0.105 inch (2.67 mm) in diameter, length to suit depth of insulation indicated.

D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of dimension indicated between face of insulation and substrate to which anchor is attached.
E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

PART 2 EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

C. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

D. Cut and trim insulation neatly to fit spaces. Butt edges and ends tight. Fit insulation tight against mechanical, electrical and other items which protrude through plane of insulation.

E. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

F. Water-Piping Coordination: If water piping is located on inside of insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

G. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.

2. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.

3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.

4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

H. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

I. Rigid Board Installation: Install rigid insulation to maintain continuous and complete thermal protection for building spaces and elements.
1. Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.
2. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 - Unit Masonry.

3.3 INSTALLED WORK

A. Protection: Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION
SECTION 072700
AIR BARRIER

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Complete air- and moisture-barrier assembly, including accessories and materials to bridge and seal air leakage pathways and gaps.

1.2 DEFINITIONS
A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
C. Air-Barrier Assembly: The collection of air-barrier materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.3 ACTION SUBMITTALS
A. Product Data: Submit manufacturer's instructions for surface conditioner compatibility, primer, mastic, membrane, temperature range for application of barrier materials.
B. Shop Drawings: For complete moisture barrier assemblies.
   1. Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
   2. Include details of interfaces with other materials that form part of air barrier.

1.4 INFORMATIONAL SUBMITTALS
A. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with air barrier.
B. Compatibility:

1.5 QUALITY ASSURANCE
A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
B. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
C. Pre-Installation Conference: Prior to installation of barrier, conduct pre-installation conference at project site.
   1. Attendance: Contractor, job superintendent, subcontractors, supplier and manufacturer's technical representative.
   2. Agenda: Cover installation and coordination procedures, protective measures and related conditions.
   3. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.
D. Mockups: Provide materials and installation of air barrier for integrated mockup. Coordinate with Section 014339 - Mockups.
1.6 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.
   1. Bond Strength: Test for cohesive and adhesive strength according to ASTM E 736. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   2. Density: Test for density according to ASTM E 605. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with fireproofing.
   4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   5. For materials failing tests, obtain applied-fireproofing manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.7 PROJECT CONDITIONS

A. Do not apply barrier during inclement weather or when air temperature is below 40 degrees F., unless manufacturer's written application instructions indicate otherwise.

B. Do not apply barrier to damp, frozen, dirty, dusty, or surfaces unacceptable to manufacturer.

1.8 WARRANTY

A. Warranty shall provide for making good, within period of 3 years, at no cost to Owner, failures of barrier to resist penetration of water, except where such failures are:
   1. Result of structural failures of building.
   2. Cracking of membrane due to temperature or shrinkage is not considered as structural failure.

B. Repair and make good barrier membrane and pay for and repair or replace affected or damaged materials or surfaces at no cost to Owner.

1.9 COORDINATION

A. Coordinate installation of moisture barrier with other systems including interface conditions at window and door openings, and to other waterproofing systems.

B. Coordinate installation of assembly over moisture barrier to protect moisture barrier from UV exposure.

PART 2 PRODUCTS

2.1 ASSEMBLY REQUIREMENTS

A. General: Provide complete air- and moisture-barrier assembly meeting the following performance requirements:
   1. Performs as a drainage plane flashed to discharge liquid-water caused by incidental condensation or water penetration to the exterior.
   2. Performs as a continuous air-barrier and vapor-barrier.
   3. Accommodates substrate movement, sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing and through-wall flashing, and transitions at perimeter conditions without deterioration and without air leakage exceeding specified limits.
   4. System Air Leakage Limit, ASTM E 283 or ASTM E 783: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft.
B. Source Limitations: Obtain primary moisture barrier assembly materials and accessories from single source from single manufacturer.

C. Material Compatibility: Assembly materials shall be compatible with one another and with adjacent materials, as demonstrated by manufacturer based on testing and field experience.

2.2 VAPOR, WATER & AIR BARRIER

A. Modified Bituminous Sheet: 40-mil-thick, self-adhering sheet consisting of 36 mils of rubberized asphalt laminated to a 4-mil-thick, cross-laminated polyethylene film with release liner on adhesive side; formulated for application with primer that complies with VOC limits of authorities having jurisdiction.

1. Physical and Performance Properties:
   a. Air Permeance, ASTM E 2178: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference.
   b. Water Vapor Permeance, ASTM E 96, Water Method: Maximum 0.10 perm.
   c. Tensile Strength, ASTM D 412, Die C: Minimum 250 psi.
   d. Ultimate Elongation, ASTM D 412, Die C: Minimum 200 percent.
   f. Water Absorption, ASTM D 570: Maximum 0.15 percent weight gain after 48-hour immersion at 70 deg F.

2. Products and Manufacturers:
   b. CCW-705 by Carlisle Coatings & Waterproofing.
   c. PW 100/40 AVB by Protecto Wrap Company.
   d. Sealight Air-Shield by W. R. Meadows Inc.
   e. ExoAir 110/110LT by Tremco.
   f. Blueskin SA by Henry Company.

2.3 ASSEMBLY ACCESSORIES

A. General: Provide compatible assembly components recommended by membrane manufacturer to produce a complete air- and moisture-barrier assembly.

B. Cleaner: As recommended by membrane manufacturer to clean substrates and surfaces to be lapped.

C. Primer: Use manufacturer's recommended solvent-based or water-based primers for concrete and concrete masonry substrates or glass-matt faced sheathing.

D. Flashing and Other Assembly Components:
   1. Substrate-Patching Membrane
   2. Crack Treatment Strips
   3. Joint Reinforcing Strips
   4. Counterflashing Strips
   5. Roof Termination Strips: For terminating at compatible roofing membrane.
   6. Opening Termination Strips: For terminating at windows, doors, curtain walls, and storefront systems.
   7. Termination Mastic.
   8. Adhesives and Tapes.

E. Joint Sealant: Provide joint sealants in compliance with Section 079200 - Joint Sealants.

F. Sprayed Polyurethane Foam Sealant: One- or two-component, foamed-in-place, polyurethane foam sealant, 1.5- to 2.0-lb/cu. ft. density; flame-spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.
G. Stainless-Steel Sheet: ASTM A 240, Type 304, 0.0250 inch thick, and Series 300 stainless-steel fasteners.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
2. Verify that concrete has cured and aged for minimum time period recommended by barrier manufacturer.
3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
4. Verify that masonry joints are flush and completely filled with mortar.
5. Verify that sleeves, ties, and other penetrating components that pass through surfaces to receive barrier are rigidly installed.
6. Verify that surfaces are free of cracks, depressions, waves or projections which may be detrimental to successful installation.
7. Ensure that exterior sheathing panels are stabilized with corners and edges fastened with appropriate screws.

B. Proceed with installation only after unsatisfactory conditions have been corrected. Starting Work of this Section means acceptance of substrate and site conditions.

3.2 SURFACE PREPARATION

A. Clean, prepare, and treat substrate according to manufacturer’s written instructions. Provide clean, dust-free, and dry substrate for moisture barrier application.

1. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
2. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
3. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

B. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

C. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for moisture barrier membrane.

D. Joint and Crack Treatment: Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Bridge and cover isolation joints, expansion joints and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with overlapping modified bituminous strips.

3.3 INSTALLATION, GENERAL

A. Transition Strips: Install strips, transition strips, and accessory materials according to manufacturer’s written instructions to form a seal with adjacent construction and maintain a continuous air barrier.

1. Where directed by manufacturer's written instructions, apply before or after application of membrane to create a shingle effect and maintain continuity of the air barrier assembly from top to bottom of structure.
2. Coordinate with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
3. Use transition membranes to tie into opening frames, spandrel panels, floor intersections and changes in substrates.
4. Apply in accordance with manufacturer's instructions, positioning, lapping, sealing and protecting as required.

B. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply so that a minimum of 3 inches of coverage is achieved over each substrate.

C. Seal top of through-wall flashings to moisture barrier with an additional 6-inch wide.
   1. At Non-Metallic Through Wall Flashing: Use modified bituminous strip.

3.4 INSTALLATION OF SHEET MEMBRANE

A. General: Install sheet membrane moisture barrier and accessory materials according to manufacturer's written instructions and according to recommendations in ASTM D 6135.
   1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous air-barrier sheet produced for low-temperature application. Do not install low-temperature sheet if ambient or substrate temperature is higher than 60 deg F.

B. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
   1. Install modified bituminous strips centered over vertical inside corners. Install 3/4-inch fillets of termination mastic on horizontal inside corners.

C. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations with termination mastic and according to ASTM D 6135.

D. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier sheet on same day. Reprime areas exposed for more than 24 hours.
   1. Prime glass-fiber-surfacéd gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.

E. Apply and firmly adhere modified bituminous sheets horizontally over area to receive air barrier. Accurately align sheets and maintain uniform 2-1/2-inch minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure airtight installation.
   1. Apply sheets in a shingled manner to shed water without interception by any exposed sheet edges.
   2. Roll sheets firmly to enhance adhesion to substrate.

F. Apply continuous modified bituminous sheets over modified bituminous strips bridging substrate cracks, construction, and contraction joints.

G. CMU: Install barrier sheet horizontally against the CMU beginning at base of wall. Align top edge of air-barrier sheet immediately below protruding masonry ties or joint reinforcement or ties, and firmly adhere in place.
   1. Overlap horizontally adjacent sheets a minimum of 2 inches and roll seams.
   2. Apply overlapping sheets with bottom edge slit to fit around masonry reinforcing or ties. Roll firmly into place.
   3. Seal around masonry reinforcing or ties and penetrations with termination mastic.
   4. Continue the membrane into all openings in the wall, such as doors and windows, and terminate at points to maintain an airtight barrier that is not visible from interior.

H. Seal exposed edges of sheet at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
I. Connect and seal exterior wall air-barrier membrane continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

J. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition material or flashing so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames with not less than 1 inch of full contact.
   1. Modified Bituminous Transition Strip: Roll firmly to enhance adhesion.
   2. Elastomeric Flashing Sheet: Apply adhesive to wall, frame, and flashing sheet. Install flashing sheet and termination bars, fastened at 6 inches o.c. Apply lap sealant over exposed edges and on cavity side of flashing sheet.
   3. Preformed Silicone-Sealant Extrusion: Set in full bed of silicone sealant applied to walls, frame, and membrane.

K. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of air-barrier membrane with foam sealant.

L. At end of each working day, seal top edge of air-barrier material to substrate with termination mastic.

M. Apply joint sealants forming part of air-barrier assembly within manufacturer’s recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

N. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten fishmouths and blisters. Patch with air-barrier sheet extending 6 inches beyond repaired areas in all directions.

O. Do not cover air barrier until it has been tested and inspected by Owner’s testing agency.

P. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
   1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
   2. Continuous structural support of air-barrier system has been provided.
   3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
   4. Site conditions for application temperature and dryness of substrates have been maintained.
   5. Maximum exposure time of materials to UV deterioration has not been exceeded.
   6. Surfaces have been primed, if applicable.
   7. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
   8. Termination mastic has been applied on cut edges.
   9. Strips and transition strips have been firmly adhered to substrate.
   10. Compatible materials have been used.
   11. Transitions at changes in direction and structural support at gaps have been provided.
   12. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
13. All penetrations have been sealed.

C. Tests: As determined by Owner's testing agency from among the following tests:
   1. Quantitative Air-Leakage Testing: Air-barrier assemblies will be tested for air leakage according to ASTM E 783.
   2. Adhesion Testing: Air-barrier assemblies will be tested for minimum air-barrier adhesion of 30 lbf/sq. in. according to ASTM D 4541 for each 600 sq. ft. of installed air barrier or part thereof.

D. Air barriers will be considered defective if they do not pass tests and inspections.
   1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
   2. Remove and replace deficient air-barrier components for retesting as specified above.

E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

3.6 CLEANING AND PROTECTION

A. Protect moisture barrier assembly from damage during application and for remainder of construction period; in accordance with manufacturer's written instructions.
   1. Protect barrier from contact with incompatible materials and sealants not approved by barrier manufacturer.
   2. Protect barrier from exposure to UV light and harmful weather exposure as required by manufacturer.
   3. If exposed to UV light or to harmful weather for more than 30 days, remove and replace barrier; or, as approved by moisture barrier manufacturer, repair and prepare the overexposed membrane and install additional, full-thickness, barrier in accordance with manufacturer’s written recommendations.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed Work, using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION
SECTION 074200
METAL PANELS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Formed Flush Aluminum Plate Panels (MP-1).
   2. Formed Box-Rib-Profile Panels (MP-2).
   3. Formed Angled-Profile Panels (MP-3).
   4. Framing and accessories for metal panels.
   5. Engineering required to comply with specified performance requirements.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
   1. Indicate dimensions, panel layout, construction details, method of anchorage, method of installation.
   2. Panel layout to match layout as indicated on Drawings.
C. Delegated Design Submittal and Shop Drawings: Where professional design services or certifications by a qualified Professional Engineer are specifically required of the Contractor by the Contract Documents, submit shop drawings submittal package with the delegated design submittal requirements in accordance with Section 013300 - Submittal Procedures.
   1. Calculations: Upon request from the Architect/Engineer only, Contractor shall submit calculations in accordance with Section 013300 – Submittal Procedures.
D. Samples: Metal panels, 36 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.3 INFORMATIONAL SUBMITTALS
A. Samples: Submit color samples for selection in accordance with Section 013300.
   1. Metal Panels: 36 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.
B. Qualification Data: For fabricator and installer.

1.4 QUALITY ASSURANCE
A. Panel system fabricator and attachment system shall be approved by the panel manufacturer.
B. Fabricator and Installer Qualifications: A single entity, well-established and experienced in metal panel fabrication and installation, acceptable to Owner and Architect, employing skilled workers who custom-fabricate and install metal panels similar to those required for this Project and whose work has a record of successful in-service performance.
   1. Installer Qualifications: Fabricator of metal panels for this project.
2. Experience: Having successfully completed a minimum of 10 previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

3. Architect reserves the right to reject metal panel fabricator if it is Architect's opinion that previous performance by fabricator has been unsatisfactory, or if any of the following will not result in required quality within time required for completion:
   a. Shop capacity and capabilities.
   b. Experience of workers.
   c. Installation capabilities and equipment.
   d. Quality or supply of material.

C. Mockups: Fabricate and erect in place. Mock-up to illustrate shape, joints, anchoring and attachment points, perforations and finish in accordance with approved sample.
   1. Joints Included in Mock-Up: Outside corner with corner bar typical in-field joint, in-field joint with snap cover, inside corner, expansion joints.
   2. Obtain Architect's acceptance of visual qualities of mock-ups before start of work. Accepted unit establishes minimum standard for work. Unit may be incorporated into work.

1.5 ENVIRONMENTAL CONDITIONS

A. Field Measurements: should be taken prior to the completion of shop fabrication whenever possible. However, coordinate fabrication schedule with construction progress as directed by the Contractor to avoid delay of work. Field fabrication may be allowed to ensure proper fit. However, field fabrication shall be kept to an absolute minimum with the majority of the fabrication being done under controlled shop conditions.

B. Verify dimensions by field measurement before panel fabrication. Design units to provide for adjustment and fitting of components during field installation. Preassemble units at shop to minimize mechanical joints, splicing and field assembly of units.

1.6 COORDINATION

A. Coordinate work directly with other trades as necessary to insure proper fitting, joining or to clearances of other work. Obtain templates as required to insure proper fitting. Verify dimensions and exchange shop drawings.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panels and sub-framing systems that fail in materials or workmanship within specified warranty period.
   1. Failures including but not limited to the following:
      a. Deterioration resulting from U.V. and weather exposure.
      b. Structural failures including rupturing, cracking, or puncturing.
      c. Deterioration of materials beyond normal weathering.
   2. Provide warranty covering panel fabrication defects and loss of specified physical and performance properties, when panels are installed in accordance with manufacturer's requirements.
   3. Provide warranty covering cost of panel removal and installation of replacement panels.
   4. Warranty Period: 10 years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Contractor shall engage a qualified Professional Engineer to provide delegated design services in accordance with Section 013300 – Submittal Procedures

B. Structural Performance: Design panels and connections in accordance with applicable codes and standards, capable of withstanding project design loads, within limits and under conditions indicated, without excessive stress or deflection.
1. Design Loads: Design and construct metal panel, including anchorages, to withstand attached dead loads, live loads and the following wind:
   b. Wind Loads: Provisions of ASCE 7-10 as indicated in the Construction Documents.
2. All other related items that are shop or field fastened to panels for purposes of placing and anchoring panels; clip angles and other members used to connect panels to structural steel or backup and shim, bolts, nuts, girts and steel angle clips at concealed connections.
3. System to accommodate movement of components without buckling, undue stress on fasteners, or other detrimental effects, when subject to seasonal temperature ranges.

C. Thermal Movement: System to provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F without causing detrimental effects to system or components.

D. Not Permitted: Vibration harmonics; wind whistles; noises caused by thermal movement; thermal movement transmitted to other building elements; loosening, weakening or fracturing of attachments or components of system.

2.2 MANUFACTURERS & FABRICATORS

A. Single Source Responsibility: Provide metal panel products by a single firm for each type of metal panel.

B. Manufacturers and Fabricators: Subject to specified requirements, provide Basis of Design product or equivalent product as approved by Architect from one of the following manufacturers:
1. ATAS International, Inc.
2. Benchmark; a Kingspan Group Company.
4. Dri-Design
5. Firestone Building Products.
6. IMETCO (Innovative Metals Company, Inc.)
7. M.G. McGrath Sheet Metal.
8. Metal Sales Manufacturing Corporation.
9. Morin; a Kingspan Group company.
11. Protean Construction Products, Inc.
12. Sobotec.
2.3 METAL PANELS

A. (MP-1) Flush Formed Aluminum Plate Panels: Dry-joint, pressure-equalized rainscreen system; aluminum plate panels, fabricated from single sheets of aluminum formed into profile for installation method indicated. Include attachment assembly components and panel stiffeners as required.
   2. Panel Configuration:
      a. Profile: Flush profile as shown on Drawings.
      b. Depth: As shown.
      c. Sizes: Varying, as shown.
   3. Aluminum Sheet: 0.125 inch thick, tension-leveled, smooth aluminum sheet, ASTM B 209.
   4. Finish: Color-anodized, AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
      a. Color: Black, as selected by Architect.

B. (MP-2) Roll-Formed Box-Rib-Profile Panels: Box-shaped (90-degree) ribs, with interlocking tongue and groove joints, installed with concealed clip fasteners. Include attachment assembly components and accessories.
   2. Panel Configuration:
      a. Profiles: Multiple, as selected by Architect from Manufacturer's full range.
      b. Panel Depth: 1-1/2 inch.
      c. Sizes: As shown.
      d. Rib Orientation: As shown.
   3. Aluminum Sheet: 0.063 inch thick, tension-leveled, smooth aluminum sheet, ASTM B 209.
   4. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755.
      a. Nominal Thickness: 0.028 inch (24 ga.).
   5. PVDF Fluoropolymer Finish: AAMA [621] [2605], containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat [and in clear topcoat].
      a. Two-Coat System: Primer and color coat.
      b. Three-Coat System: Primer, color coat and clear topcoat.
      c. Mica Two-Coat System: Primer, color coat with suspended mica flakes.
      d. Metallic Three-Coat System: Primer, color coat and clear topcoat with suspended metallic flakes.

C. (MP-3) Roll-Formed Angled-Rib-Profile Panels: Angle profile ribs, with interlocking tongue and groove joints, installed with concealed clip fasteners. Include attachment assembly components and accessories.
   1. Basis of Design: Morin Pulse Wall Series; PULSE 1, PULSE 2, PULSE 3, PULSE 4 & PULSE 9
   2. Panel Configuration:
      a. Profiles: Multiple, as selected by Architect from Manufacturer's full range.
      b. Panel Depth: 1-1/2 inch.
      c. Sizes: As shown.
      d. Rib Orientation: As shown.
   3. Aluminum Sheet: 0.063 inch thick, tension-leveled, smooth aluminum sheet, ASTM B 209.
   4. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755.
      a. Nominal Thickness: 0.028 inch (24 ga.).
5. PVDF Fluoropolymer Finish: AAMA [621] [2605], containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat [and in clear topcoat].
a. Two-Coat System: Primer and color coat.
b. Three-Coat System: Primer, color coat and clear topcoat.
c. Mica Two-Coat System: Primer, color coat with suspended mica flakes.
d. Metallic Three-Coat System: Primer, color coat and clear topcoat with suspended metallic flakes.

6. Color: COLOR: METALLIC - 3 VARIATIONS OF CHAMPAGNE TO MATCH ARCHITECTS SAMPLE

2.4 SYSTEM COMPONENTS

A. Wall Panel Accessories: Provide components required for a complete wall panel assembly including trim, copings, fascia, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of panels unless otherwise indicated.

B. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and finish indicated.

C. Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653, G90 coating designation or ASTM A 792, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
   1. Subframing Anchors: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide EPDM or neoprene sealing washers.
      a. Subframing-to-Concrete: Stainless steel or zinc-coated, self-tapping (Tapcon).
      b. Subframing-to-Steel Stud: Zinc-coated, self-tapping

2. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

D. Flashing and Trim: Formed from 0.018-inch-minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish. Refer to Section 079000 - Joint Sealants.
   1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polysobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
   2. Joint Sealant for Exterior and Exposed Seals: ASTM C 920 silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain watertight; and as recommended in writing by metal panel manufacturer.

2.5 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing.
1. Comply with indicated profiles and with dimensional and structural requirements.
2. Shop fabricate system and assemble units ready for installation.
3. Panel fabricator shall field measure as required to insure level, square and true to line, installation.

B. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
   5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
   6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
      a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Finishes for Concealed Surfaces: Comply with NAAMM's "Metal Finishes Manual" for recommendations for applying and designating finishes.
   1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
   2. Concealed Steel Items: Galvanized in accordance with ANSI/ASTM A653 to 2.0 oz/sq ft primed with iron oxide paint.
   3. Apply one coat of bituminous paint to concealed aluminum and steel surfaces in contact with cementitious or dissimilar materials.
   4. Primer: FS TT-P-31; for shop application and field touch-up.
   5. Touch-Up Primer for Galvanized Surfaces: FS TT-P-641; TT-P-645.
PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of work.
   1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
   2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

B. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer’s written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   1. Shim or otherwise plumb substrates receiving metal wall panels.
   2. Flash and seal metal wall panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until weather barrier and flashings that will be concealed by metal wall panels are installed.
   3. Install screw fasteners in predrilled holes.
   4. Locate and space fastenings in uniform vertical and horizontal alignment.
   5. Install flashing and trim as metal wall panel work proceeds.
   6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
   7. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
   8. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
   9. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.

B. Fasteners: Use fasteners of type and size that will secure wall components in compliance with design load requirements, without corroding.
   1. Steel Wall Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized steel fasteners for surfaces exposed to the interior.
   2. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized steel fasteners for surfaces exposed to the interior.
   3. Copper Wall Panels: Use copper, stainless-steel or hardware-bronze fasteners.
   4. Stainless-Steel Wall Panels: Use stainless-steel fasteners.
   5. Conceal fasteners and expansion provisions, where possible, in exposed work and locate to minimize possibility of leakage.
C. Metal Protection: Do not install metal wall panel system with non-compatible materials. Protect the metal wall panels from masonry and products containing lime by leaving the protective coating on the zinc until project and clean-up completion. Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal wall panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.

1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

3.3 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorages according to ASTM C 754, metal wall panel manufacturer's written recommendations, and approved Shop Drawings.

1. Install girts tight to moisture barrier (MB).

C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.4 TOLERANCES

A. Panel Erection Tolerances: Erect formed metal panel sheet metal work plumb and true, in alignment and in relation to lines and dimensions shown. Variations of 1/8 inch in 10 feet, non-accumulative, is maximum permissible for plumb, warp, bow and alignment.

1. Maximum Offset From True Alignment Between Adjacent Members Butting In Line: 1/16 inch.
2. Maximum Variation from Plane or Location Indicated on Drawings: 1/8 inch.

3.5 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.
B. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Fully-adhered TPO membrane roofing systems (TPO).

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
   1. Base flashings and membrane terminations.
   2. Tapered insulation, including slopes.
   3. Roof plan showing orientation of steel roof deck and orientation of membrane roofing and fastening spacings and patterns for mechanically fastened membrane roofing.
   4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

1.3 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified Installer and manufacturer.
B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   1. Submit evidence of compliance with performance requirements.
C. Field quality-control reports.

1.4 QUALITY ASSURANCE
A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for membrane roofing system identical to that used for this Project.
B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.5 PROJECT CONDITIONS
A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.6 WARRANTY
A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
   1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of membrane roofing system.
   2. Warranty Period: 20 years from date of Substantial Completion.
PART 1 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings shall remain watertight.
   1. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
   2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D 3746, ASTM D 4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Wind Uplift Resistance: Design roofing system to resist wind uplift pressures in accordance with FM Global Requirements when tested according to FM Approvals 4474, UL 580, or UL 1897.

2.2 ROOFING SYSTEM, GENERAL

A. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

B. Source Limitations: Obtain roofing system components from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.

C. Manufacturers: Provide Basis of Design or approved equivalent roofing system, from one of the following manufacturers:
   1. Carlisle SynTec Incorporated.
   2. Firestone Building Products Company.
   3. GAF Materials Corporation.
   5. Johns Manville Roofing Systems
   6. Mule-Hide Products, Co..
   7. Stevens Roofing Systems; Division of JPS Elastomerics.
   8. Versico Incorporated.

D. System Basis of Design: Sure-Weld TPO Fully-Adhered System by Carlisle SynTec.

2.3 SYSTEM CONFIGURATIONS

A. System Configurations: As indicated in Drawings and indicated below.

B. (TPO-1) Fully-Adhered TPO Roof System over Composite Concrete Deck:
   2. Insulation: Polyisocyanurate boards, fully-adhered base layer, fully-adhered upper layers built-up as required to achieve specified R-value.
   3. Cover Board: Gypsum board type.
   4. Roof Membrane: 60 mils membrane, fully-adhered.

C. (TPO-2) Fully-Adhered TPO Roof System over Metal Deck:
   3. Insulation: Polyisocyanurate boards, mechanically-fastened base layer, fully-adhered upper layers built-up as required to achieve specified R-value.
   4. Cover Board: Gypsum board type.
   5. Roof Membrane: 60 mils membrane, fully-adhered.
2.4 PRIMARY ROOFING MEMBRANE
   A. Thermoplastic Polyolefin (TPO) Sheet: ASTM D 6878, internally-reinforced with fabric or scrim.
      1. Thickness: 60 mils, nominal.
      2. Exposed Face Color: White.

2.5 AUXILIARY ROOFING MATERIALS
   A. Provide auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
      1. Adhesives and Sealants: Complying with VOC limits of authorities having jurisdiction.
   B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as roof membrane.
   C. Bonding Adhesive: Manufacturer's water-based adhesive.
   D. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
   E. Metal Battens: Manufacturer's standard aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, prepunched.
   F. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
   G. Slip Sheet: Manufacturer's standard, of thickness required for application.
   H. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
   I. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

2.6 SUBSTRATE BOARD
   A. Substrate Board: ASTM C1177, glass-mat-faced, water-resistant gypsum substrate board.
      1. Thickness: As shown.
      2. Surface finish: Factory primed or unprimed, as recommended by system Manufacturer.
      4. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.7 VAPOR RETARDER
   A. Self-Adhering-Sheet Vapor Retarder: ASTM D1970, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil- total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

2.8 INSULATION
   A. General: Preformed roof insulation boards manufactured or approved by roof system manufacturer.
      2. Provide flat boards and factory-tapered boards as required to achieve minimum slope of 1/4 inch per 12 inches, unless otherwise shown.
3. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Grade 3, Class 1 or 2 as required by Manufacturer, felt or glass-fiber mat facer on both major surfaces; with 25 psi minimum compressive strength.

C. Insulation Accessories: Provide roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
   1. Full-Spread Applied Insulation Adhesive: Insulation manufacturer’s recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
   2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

2.9 COVER BOARD
   A. Cover Board: ASTM C1177, glass-mat-faced, water-resistant gypsum substrate board.
      1. Thickness: As shown.
      2. Surface finish: Factory primed or unprimed, as recommended by system Manufacturer.
   B. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

2.10 WALKWAYS
   A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick, and acceptable to membrane roofing system manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
      1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
      2. Verify that wood cant, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   B. Steel Roof Deck:
      1. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 - Steel Decking.
      2. Perform fastener-pullout tests according to roof system manufacturer’s recommendations. Submit test result within 24 hours of performing tests. Include manufacturer’s requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.
   C. Concrete Roof Deck: Verify that minimum concrete drying period recommended by roofing manufacturer has passed.
1. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than 75 percent, or as recommended by roofing system manufacturer, when tested according to ASTM F2170.
   a. Test Frequency: One test probe per each 1000 sq. ft. of roof deck, with not less than three test probes.
   b. Submit test reports within 24 hours of performing tests.
2. Verify that concrete-curing compounds that impair adhesion of roofing components to roof deck have been removed.
3. Precast Concrete Roof Decks: Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.

D. Proceed with installation only after unsatisfactory conditions have been corrected.
E. Proceed with installation of roofing only after substrate construction has been completed, and after penetrating components have been installed, so that membrane will not be penetrated or damaged by subsequent work.

3.2 PREPARATION
A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing manufacturer's written instructions. Remove sharp projections.
B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.3 INSTALLATION, GENERAL
A. Install roofing system according to roofing system manufacturer's written instructions, SPRI's Directory of Roof Assemblies assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.
B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
C. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under Section 072700 - Air Barriers.

3.4 SUBSTRATE BOARD INSTALLATION
A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.
   1. Steel Roof Decks: Install substrate board at right angle to flutes of deck. Locate end joints over crests of steel roof deck.
   2. Tightly butt substrate boards together.
   3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   4. Fasten substrate board to top flanges of steel deck according to recommendations in Manufacturer's written instructions and FM Global Property Loss Prevention Data Sheet 1-29.
   5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.

3.5 VAPOR RETARDER INSTALLATION
A. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.
B. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches, respectively.
1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Seal laps by rolling.

3.6 INSULATION INSTALLATION
A. General: Comply with roofing system and insulation manufacturer’s written instructions for installing roof insulation.
1. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
2. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
3. Make joints between adjacent insulation boards not more than 1/4 inch in width.
4. Fill gaps exceeding 1/4 inch with insulation.
5. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches. Trim insulation so that water flow is unrestricted.
6. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
7. Install with joints staggered from joints in adjacent rows and in previous layers, in accordance with roofing manufacturer’s instructions.
B. Base Layer Installation Over Metal Decking: Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
1. Fasten insulation according to requirements in SPRI’s Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
2. Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
C. Base Layer Installation Over Concrete Decks: Adhere base layer of insulation in accordance with Manufacturer’s written instructions.
D. Upper Layers of Insulation: Adhere each layer of insulation to substrate using adhesive according to Manufacturer’s written instructions.
E. Insulation Installation for Ballasted System: Loosely lay base layer over substrate and each subsequent upper layer.

3.7 INSTALLATION OF COVER BOARDS
A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.
1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump. Trim cover board so that water flow is unrestricted.
3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate using adhesive according to Manufacturer’s written instructions.

3.8 ROOF MEMBRANE INSTALLATION, GENERAL
A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer’s written instructions.
B. Unroll membrane roof membrane and allow to relax before installing.
C. Start installation of roofing in presence of roofing system manufacturer's technical personnel and Owner's testing and inspection agency.

D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

E. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.
   1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
   2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
   3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

3.9 ADHERED ROOF MEMBRANE INSTALLATION

A. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.

3.10 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.11 WALKWAY INSTALLATION

A. Flexible Walkways: Install flexible walkways at locations indicated on Drawings, in accordance with roof membrane manufacturer's warranty requirements. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

B. Roof-Paver Walkways: Install walkway roof pavers at locations as shown on Drawings, in accordance with manufacturer's written instructions.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, flashings, protection, and drainage components, and to furnish reports to Architect.

B. Flood Testing: Flood test each roofing area for leaks, according to recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
   1. Perform tests before overlying construction is placed.
   2. Flood each area for minimum of 24 hours.
   3. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
a. Cost of retesting is the responsibility of the Contractor.

4. Testing agency shall prepare survey report indicating locations of initial leaks, if any, and final survey report.

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
   1. Notify Architect and Owner 48 hours in advance of date and time of inspection.

D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

E. Roofing system will be considered defective if it does not pass tests and inspections.
   1. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.13 INSTALLED WORK

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION
SECTION 076200
SHEET METAL & FLASHING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Prefinished sheet metal flashing, roof edges and parapets, coping, expansion and contraction
      joint covers, parapet wall covers (SMF).
   2. Manufactured roof edge and coping systems (CP).
   3. Flexible membrane flashing.

1.2 COORDINATION
A. Coordinate with Section 074200 - Metal Panels for coping and other sheet metal work by metal
   panel (MP) fabricator.
B. Coordinate sheet metal layout and seams with penetrations and with joints and seams in adjacent
   materials.
C. Coordinate sheet metal installation with adjoining roofing and wall materials, joints, and seams to
   provide leakproof, secure, and noncorrosive installation.
D. Coordinate work of this section with interfacing and adjoining work for proper sequencing of each
   installation. Ensure best possible weather resistance and durability of work and protection of
   materials and finishes.

1.3 ACTION SUBMITTALS
A. Product Data: For manufactured components. Include construction details, material descriptions,
   dimensions of individual components and profiles, and finishes for each manufactured product and
   accessory. Include identification of material, thickness, weight, and finish for each type.
B. Shop Drawings: For sheet metal flashing and trim. Include plans, elevations, sections, and
   attachment details. Indicate installation layouts, expansion-joint locations, spacing of fasteners,
   cleats, clips, and other attachments. Distinguish between shop- and field-assembled work.
C. Samples: For each type of sheet metal and finishes, 12 inches long by actual width of unit,
   including finished seam and in required profile.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For fabricator and manufacturers.

1.5 QUALITY ASSURANCE
A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and
   trim similar to that required for this Project and whose products have a record of successful in-
   service performance.
B. Pre-Installation Conference: Conduct a conference to review and discuss the following:
   1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment,
      and facilities needed to make progress and avoid delays.
   2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and
      condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
   1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping, and protect film from exposure to sunlight and high humidity.
B. Do not store materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal materials away from uncured concrete and masonry.

1.7 WARRANTY
A. Special Finish Warranty: Submit manufacturer's 20 year written warranty covering failure of the factory-applied exterior finish on sheet metal and agreeing to repair finish or replace sheet metal that evidences finish deterioration. Deterioration of finish includes, but is not limited to, color fade, chalking, cracking, peeling, and loss of film integrity.
B. Weathertight Warranty: In which Installer agrees to repair or replace components of sheet metal flashing that fail in materials or workmanship within 5 years of Date of Substantial Completion. Failures include, but are not limited to, the following:
   1. Structural failures including, but not limited to, rupturing, cracking, or puncturing.
   2. Wrinkling or buckling.
   3. Loose parts.
   4. Failure to remain weathertight, including uncontrolled water leakage.
   5. Deterioration of metals, metal finishes, and other materials beyond normal weathering, including nonuniformity of color or finish.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
B. FM Approvals Listing: Manufacture and install copings and roof edge flashings that are listed in FM Approvals’ "RoofNav" and approved for windstorm classification, [Class 1-60] [Class 1-75] [Class 1-90] [Class 1-105] [Class 1-120]. Identify materials with name of fabricator and design approved by FM Approvals.
C. SPRI Wind Design Standard: Manufacture and install copings and roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:
   1. Design Pressure: As indicated on Drawings.
D. Thermal Movement: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

E. Install sheet metal and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking and fastener disengagement.

F. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

2.2 ALUMINUM FLASHING

A. (SMF-1) Prefinished Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth and flat surface.

1. Thickness: 0.040 inch, minimum.

2. Fasteners: Aluminum or Series 300 stainless steel.

3. Finish: Custom color as selected by Architect to match MP-2.
   a. Color-Anodized Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
   b. PVDF Fluoropolymer Finish: AAMA 2605, containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat [and in clear topcoat].
      1) Two-Coat System: Primer and color coat.
      2) Three-Coat System: Primer, color coat and clear topcoat.
      3) Mica Two-Coat System: Primer, color coat with suspended mica flakes.
      4) Metallic Three-Coat System: Primer, color coat and clear topcoat with suspended metallic flakes.
   c. Concealed Finish: Pretreat with manufacturer's standard acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 MANUFACTURED ROOF SPECIALTIES

A. Manufacturers: Subject to compliance with requirements, provide Basis of Design product or approved equal by one of the following:

1. Allied Signals, Inc..
2. ATAS International, Inc.
3. Castle Metal Products.
5. Hickman Company, W. P.
8. Merchant & Evans, Inc.
9. Metal-Era, Inc.
10. Metal-Fab Manufacturing, LLC.

B. (CP-1) and (CP-2) Manufactured Aluminum Copings: Manufactured coping system consisting of snap-on coping cap, concealed anchorage; factory- mitered and continuously-welded corners and end cap, and concealed splice plates with same finish as coping caps.

1. Coping-Cap: Extruded aluminum, 0.125-inch thick, ASTM B 221, alloy and temper recommended by manufacturer for type of use and finish indicated.
2. Anchor Support Cleat: Concealed, 20 gauge galvanized-steel sheet, 12 inches wide, with stainless steel spring mechanically locked to cleat.
3. Fasteners: Aluminum or Series 300 stainless steel.

C. Finishes:
1. CP-1 Color: Custom color as selected by Architect to match adjacent MP-1 or MP-2.
2. CP-2 Color: Custom color as selected by Architect to match MP-3.
3. Color-Anodized Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
4. PVDF Fluoropolymer Finish: AAMA 2605, containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat [and in clear topcoat].
   a. Two-Coat System: Primer and color coat.
   b. Three-Coat System: Primer, color coat and clear topcoat.
   c. Mica Two-Coat System: Primer, color coat with suspended mica flakes.
   d. Metallic Three-Coat System: Primer, color coat and clear topcoat with suspended metallic flakes.
5. Concealed Finish: Pretreat with manufacturer’s standard acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.4 FLEXIBLE MEMBRANE FLASHING
A. (MEMB FLASH-1) Self-Adhering, High-Temperature Sheet Membrane Flashing: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing and flashing. Provide primer according to written recommendations of underlayment manufacturer.
   2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F or lower.
   3. Manufacturers and Products:
      a. Carlisle Coatings & Waterproofing Inc.; CCW WIP 300HT
      b. Carlisle Coatings & Waterproofing Inc.; CCW MiraDRI WIP 300 High Temperature
      c. Grace Construction Products; Grace Ultra.
      d. Grace Construction Products; Grace Ice and Water Shield HT.
      e. Henry Company; Blueskin PE200 HT.
      f. Owens Corning; WeatherLock Metal High-Temperature Underlayment.
      g. Protecto Wrap Company; Protecto Jiffy Seal Ice & Water Guard HT.
      h. SDP Advanced Polymer Products Inc; Palisade SA-HT.
B. (MEMB FLASH-2) EPDM Rubber Sheet Membrane Flashing: ASTM D 6134, Type I, 60-mil- thick flexible sheet, unreinforced, formed from EPDM.
   1. Manufacturers:
      a. Carlisle Coatings & Waterproofing Inc..
      b. Firestone Building Products.
      c. JohnsManville.
      d. Versico.
   2. Accessories: Furnish auxiliary materials including sheet flashing and bonding adhesive, recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.

2.5 ACCESSORIES
A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal unless otherwise indicated.
B. Anchorage: Nails and screws of hot dip zinc coated steel. Use screws where exposed anchorage is required. Screws minimum 1-1/2 inch long with neoprene washer under screw head. Exposed surfaces with finish to match color of sheet metal.

C. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

E. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.

2.6 FABRICATION

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

2. Obtain field measurements for accurate fit before shop fabrication.

3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

C. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.

D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Finishes:

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

3. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrate and conditions under which flashing and sheet metal work is to be performed. Do not proceed with work until unsatisfactory conditions have been corrected.
3.2 INSTALLATION
A. Install sheet metal work in accordance with reviewed shop drawings and Architectural Sheet Metal Manual with sharp clean breaks.
B. Lower edge of flashing, counter flashing and exposed metal edges shall be turned back into hemmed edge.
C. Flashing shall be securely fastened and water and weatherproof. Neatly install with sharp clean breaks. Metal work at roof shall meet roofer’s requirements and approval.
D. Butt and locked joint in metal work shall be watertight. Joints shall be lapped in direction of flow.
E. Provide lead wedges where required to hold metal firmly in place.
F. Install work with proper allowance for expansion and contraction from thermal changes.
G. Prior to starting work, nailers and blocking shall be true to size and line and securely anchored. Do not proceed until corrections are made so straight, level, plumb and properly sized work results.
H. Carefully form flashings, including at masonry, to conform to material dimensions as shown and according to field dimensions as verified.
I. Join lengths of gutters and downspouts with formed seams sealed watertight. Flash and seal gutters to downspouts. Slope gutters to downspout.

3.3 LOCATION OF JOINTS IN METAL
A. Center roof edge cover joints on other building features, symmetrical on facade, with joints not to exceed 10 feet o.c., as directed by Architect.
B. Joints in other metal work may be placed where convenient to metal lengths, not to exceed 10 feet lengths.
C. Cut metal for installations to maintain uniform 1/4 inch joint.

3.4 CONSTRUCTION OF END JOINTS
A. Butt Joints with Backplate for Expansion: Provide backplates same gauge and metal as flashing, 6 inch wide (2-7/8 inch each side of joint) conforming to exact shape of back of metal and full profile of metal after forming (except hems).
   1. At both ends of each length of flashing metal, provide not less than 3 bent clips riveted near end, to receive backplate. Backplates are to slip under bent clips and shall form tight contact with flashing or cover metal.
   2. In installation, butter bed of sealant on backplate and slide section of metal onto backplate, such that backplate fits into clips to hold metal tight and in perfect alignment. Repeat until metal has been set. At joints, install screws with neoprene washers through backplate without fastening to metal flashing length. (Notch out ends of flashing metal to accommodate screw heads and to eliminate obstructions for metal expansion.) Provide screw with neoprene washer at center of each length of roof metal flashing. Provide keepers or cleats to keep metal in place.
B. Locked Cover Strips: Cover strip shall have same profile as flashing and be formed with single lock seam to metal each side of joint. Locked seam joints shall have about 3/4 inch seam lock, with flashing spaced about 3/8 inch and shall permit movement at each joint.
C. Lapped Joints: Lap 3 inches in direction of water flow. At counterflashings, lock bottom edges together.
D. Sealant: Apply concealed sealant in accordance with requirements of Section 079000 - Joint Sealers.
E. At corners, inside or outside type, provide neat corner sections built-up in shop; with soldered joints and follow profile of adjacent metal. No nails permitted at exposed surfaces of exposed roof metal, only screws shall be used. Set roof edges in cooperation with roofer. Form angles to lesser degrees than required to insure snug fit after installation.

3.5 MEMBRANE FLASHING
   A. Install membrane flashing over metal flashing with termination bar and sealant at top edge. Install membrane in accordance with manufacturer’s directions to maintain watertight integrity of flashing materials and installation. Lengths shall be as long as possible by rolls of material. Lap ends minimum 2 inches, seal entire lap with adhesive and clean free of residue.

3.6 COUNTERFLASHING AND CURB FLASHING
   A. Install metal counterflashing after membrane flashing is installed. Secure with screws through neoprene washers and locate not to exceed 18 inches o.c. Lap joints and lock lower edges together.
   B. Install counterflashing to provide watertight closure over top of roofing flashing. Corners at curbs shall be sealed watertight. Height of counterflashing above membrane as indicated, with counterflashing carried down 45 degrees cant strip to about 1/2 inch above roof insulation. Bottom edge shall be hemmed to eliminate sharp edges.
   C. Counter-flash mechanical and electrical items projecting through membrane roofing.

3.7 ERECTION TOLERANCES
   A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.8 INSTALLED WORK
   A. Cleaning: Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering. Clean off excess sealants.
   B. Protection: Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer’s written installation instructions. On completion of installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.
   C. Damaged Work: Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION
SECTION 07 72 00
ROOF CURBS

GENERAL

1.1 SUMMARY
A. Section Includes: Roof curbs.

1.2 COORDINATION
A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of roof accessory.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: For roof accessories.
   1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
C. Delegated-Design Submittal: For roof curbs indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
   2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
   1. Size and location of roof accessories specified in this Section.
   2. Method of attaching roof accessories to roof or building structure.
   3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
   4. Required clearances.
B. Sample Warranties: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.
PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design roof curbs to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Wind-Restraint Performance: As indicated on Drawings.

2.2 ROOF CURBS

A. Manufacturers:
   1. Curbs, Inc..
   2. The Pate Co..
   4. Thybar Corporation.

B. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints and integrally formed deck-mounting flange at perimeter bottom.

C. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

D. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.

E. Material: Zinc-coated (galvanized) steel sheet, thickness as recommended by Manufacturer for intended use.
   1. Finish: Two-coat fluoropolymer.
   2. Color: As selected by Architect from manufacturer’s full range.

F. Construction:
   1. Curb Profile: Manufacturer's standard compatible with roofing system.
   2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
   3. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
   4. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
   5. Insulation: Factory-installed glass-fiber board insulation.
   6. Liner: Same material as curb, of manufacturer’s standard thickness and finish.
   8. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
9. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.

10. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

2.3 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
   1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.

C. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

2.4 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install roof accessories according to manufacturer's written instructions.
   1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
   2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
   3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
   4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of uncoated aluminum and stainless steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.


C. Roof Curb Installation: Install each roof curb so top surface is level.

D. Seal joints as required by roof accessory manufacturer.

END OF SECTION
SECTION 07 72 33
ROOF HATCHES

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Prefabricated roof hatches and accessories for straight ladder access (RH-1).

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, materials, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

1.3 QUALITY ASSURANCE
A. Standards: Comply with the following:
   1. SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.
   2. NRCA's "Roofing and Waterproofing Manual" details for installing units.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Cover and curb shall be thermally broken to prevent heat transfer between interior and exterior surfaces.
B. Entire assembly shall be weathertight with fully welded corner joints on cover and curb.

2.2 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide Basis of Design or equivalent products by one of the following:
   1. Babcock-Davis.
   2. Bilco Company.
   4. Thybar Corporation.

2.3 VERTICAL LADDER ACCESS (THERMALLY-BROKEN)
A. (RH-1) Thermally-Broken, Ladder Access
   1. Basis-of-Design: Type E-50TB Roof Hatch by The BILCO Company.
      a. Size: 36 inches by 36 inches.
   2. Performance characteristics:
      a. Cover and curb shall be thermally broken to prevent heat transfer between interior and exterior surfaces.
      b. Cover shall be reinforced to support a minimum live load of 40 psf (195kg/m2) with a maximum deflection of 1/150th of the span or 20 psf (97kg/m2) wind uplift.
      c. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
d. Operation of the cover shall not be affected by temperature.
e. Entire hatch shall be weather tight with fully welded corner joints on cover and curb.

3. Modifications for Acoustic Performance: Provide continuous sound-seal gasket at cover perimeter.

4. Cover: Shall be 11 gauge (2.3mm) aluminum with a 5” (127mm) beaded flange with formed reinforcing members. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. Cover shall have a heavy extruded EPDM rubber gasket bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.

5. Cover insulation: Shall be 3” (75mm) thick polyisocyanurate with an R-value = 20.3 (U=0.279 W/m²K), fully covered and protected by an 18 gauge (1mm) aluminum liner.

6. Curb: Shall be 12” (305mm) in height and of 11 gauge (2.3mm) aluminum. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. The curb shall be formed with a 5-1/2" (140mm) flange with 7/16” (11mm) holes provided for securing to the roof deck. The curb shall be equipped with an integral metal cap flashing of the same gauge and material as the curb, fully welded at the corners, that features the Bil-Clip® flashing system, including stamped tabs, 6” (153mm) on center, to be bent inward to hold single ply roofing membrane securely in place.

7. Curb insulation: Shall be 3” (75mm) thick polyisocyanurate with an R-value = 20.3 (U=0.279 W/m²K).

8. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe welded to the curb assembly.

9. Hardware
   a. Heavy stainless steel pintle hinges shall be provided
   b. Cover shall be equipped with a spring latch with interior and exterior turn handles
   c. Roof hatch shall be equipped with interior and exterior padlock hasps.
   d. The latch strike shall be a stamped component bolted to the curb assembly.
   e. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1” (25mm) diameter red vinyl grip handle to permit easy release for closing.
   f. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed. [For installation in highly corrosive environments or when prolonged exposure to hot water or steam is anticipated, specify Type 316 stainless steel hardware].
   g. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.

10. Finishes: Factory finish shall be mill finish aluminum.

PART 3 EXECUTION

3.1 INSPECTION
   A. Verify that roof hatch installation will not disrupt other trades. Verify that the substrate is dry, clean, and free of foreign matter. Report and correct defects prior to any installation.

3.2 INSTALLATION
   A. Install roof hatches in accordance with manufacturer’s recommendations.
   B. Coordinate with installation of roofing system and related flashings. Provide weather tight installation.
C. Anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures.

D. Test operate units and adjust for proper operation.

E. Clean and lubricate joints and hardware.

END OF SECTION
SECTION 077236
SMOKE VENTS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Prefabricated, acoustically-rated automatic smoke vents with upward acting doors, complete with support curb, operable hardware, counterflashings and automatic venting; and motorized operating system (SV-1).

1.2 COORDINATION
A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.
C. Coordinate motorized operating system and accessory devices to be compatible, including:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of smoke vent indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
   1. Include diagrams for power, signal, and control wiring.
C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
   1. Size and location of roof accessories specified in this Section.
   2. Method of attaching roof accessories to roof or building structure.
   3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
   4. Required clearances.
B. Product Test Reports and Certificates: For each type of acoustic smoke vent assembly, for tests performed by a qualified testing agency.
   1. Submit certified copies of 1/3 Octave Band Transmission Loss test data and STC rating as issued by an accredited independent acoustical laboratory.
1.5 **CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.6 **QUALITY ASSURANCE**

A. Provide units which have been tested, listed and labeled by FM.

B. Laboratory Certification: Acoustical testing of submitted doors assemblies shall be conducted in an accredited independent acoustical laboratory.
   1. Sound transmission loss values shall be determined in accordance with ASTM E90.
   2. Sound Transmission Class (STC) shall be determined in accordance with ASTM E413.

1.7 **MAINTENANCE AGREEMENT**

A. Continuing Maintenance Proposal: Submit proposal to the Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date of Substantial Completion. State services, obligations, conditions, and terms for agreement period and for future renewal options.

**PART 2 PRODUCTS**

2.1 **PERFORMANCE REQUIREMENTS**

A. General Performance: Entire smoke vent shall be weathertight with fully welded corner joints on cover and curb, and shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Loads: Covers shall be reinforced to support a minimum live load of 40 psf with a maximum deflection of 1/150th of the span or 90 psf wind uplift.
   1. When release is actuated, lid shall open against 10 psf snow or wind load and lock in position.

C. Acoustical Performance Requirements: Provide smoke vent assemblies identical to those of assemblies tested as sound-retardant units by an acoustical testing agency, and have the following minimum ratings:
   1. Sound Transmission Class (STC) Rating per ASTM E413: STC 50, and with energy average over the 1/3 octave band center frequencies as follows:

<table>
<thead>
<tr>
<th>Octave Band Center Frequency, Hz</th>
<th>Minimum Sound Transmission Loss (dB re 20 µPa)</th>
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<tr>
<td>125</td>
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<td>51</td>
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D. Standards: Provide smoke vents that are:
   1. Tested and listed to comply with UL 793.
   2. Labeled by an approved testing agency in accordance with IBC section 1703.5.
   3. Manufactured, installed, tested and maintained in accordance with NFPA 204.
   4. Tested, listed and labeled by FM Approvals.

2.2 **PRODUCTS AND MANUFACTURERS**

A. Source Limitations: Obtain steel acoustic smoke vent assemblies, including lids, curbs, sound control seals, hardware and other components from single source from single manufacturer.

B. Products and Manufacturers: Subject to compliance with specified requirements, provide Basis of Design or equivalent product as approved by Architect, by one of the following Manufacturers:
1. Babcock-Davis.
2. Bilco Company.
3. Dur-Red Products
5. Thybar Corporation.

2.3 ACOUSTICALLY-RATED SMOKE VENTS
A. (SV-1) Hatch-Type Heat and Smoke Vents: Acoustically-rated, quad-leaf automatic hatch-type smoke vent; insulated double-walled upper (exterior) and lower (interior) door panels with continuous weathertight perimeter gaskets; equipped with automatic self-lifting mechanisms and UL-listed fusible links rated at 165 deg F; mounted on double-walled insulated curbs; equipped with electric motorized operating system as recommended by smoke vent Manufacturer.
2. Size: 66 inches by 144 inches.
3. Heat and Smoke Vent Standard: Provide units that have been tested and listed to comply with UL 793 and are FM Approved.
   a. Roof vents must be labeled by an approved testing agency as outline in IBC section 1703.5.

2.4 COMPONENTS
A. Covers, Upper (Exterior) and Lower (Interior): 14 gauge paint bond G-90 galvanized steel with a 5-inch beaded flange with formed reinforcing members.
   1. Gasket: PVC gaskets shall be permanently adhered to the underside of the covers and on top of the curb.
   2. Cover Insulation: Shall be fiberglass of 3" (76mm) in thickness, fully covered and protected by a 14 gauge paint bond G-90 galvanized steel liner.
   3. Each upper cover shall be equipped with a positive automatic hold-open arm with red vinyl grip release, and a heavy extruded thermoplastic rubber gasket fitted into a retainer that is mechanically fastened to the interior of the cover to assure a continuous seal when compressed to the top surface of the curb.
   4. Each lower cover shall be continuously hinged and shall be 14 gauge paint bond G-90 galvanized steel prime painted. Insulation in the lower covers shall be glass fiber 2" thick fully covered and protected by a 22 gauge paint bond G-90 galvanized steel liner prime painted.
B. Curb: Double-walled insulated curbs, welded or mechanically fastened and sealed corner joints, integral condensation gutter, and cap flashing.
   1. Steel: 14 gauge galvanized steel inner curb, 14 gauge galvanized steel outer curb.
   2. Curb Insulation: 3-inches fiberglass insulation, fully enclosed by a 14 gauge paint bond G-90 galvanized steel liner.
C. Hinge: Zinc plated steel tamper proof hinge contained within vent as part of spring assembly.
D. Springs: High pressure gas springs enclosed in telescoping tubes, designed to open vent covers automatically against 10 pounds per square foot wind or snow load when released.
E. Hardware: Manufacturer's standard, corrosion resistant or hot-dip galvanized; with hinges, hold-open devices, and independent manual-release devices for inside and outside operation of lids.
F. Lifting Mechanisms: Corrosion resistant gas springs open covers automatically against a 10 lb/ft² snow/wind load; with built in dampers to assure a controlled rate of opening and automatically lock the covers in the full open position. Provide release mechanism to allow the covers to be closed.
G. Latch Mechanism: 24 or 110-volt electric thermo-link release mechanism linked to alarm system to release vent electrically. Provide positive hold/release mechanism with a separate latching point for each cover controlled by a single UL listed 165°F fusible link. Fusible link shall be curb mounted on a non-hinged end to allow the latching mechanism to be easily reset from the roof level.
1. Provide cover-mounted rigging release devices, 165 degree fusible links, secure rigging underside of each cover.
2. Design latching mechanisms to securely hold the covers in the closed position against wind uplift forces without overstressing fusible links.

2.5 ELECTRIC MOTOR OPERATING SYSTEM

A. Provide operating system suitable for Project conditions, designed for smoke vent size, type, weight, and operation frequency; and in accordance with the following requirements:

B. Motors: For each new smoke vent unit, provide two (2) single-phase, single-speed electric motors, with capacity and torque characteristics sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor; with manufacturer's standard weatherproof enclosures.
1. Electrical Characteristics: 115 VAC motors with 24 VDC relay to allow electric actuation.
2. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

C. Controls: For each new and existing smoke vent unit, provide one (1) wall-mounted three-button-operated station with dual contacts to operate both motors.
1. Remote Control Station: Momentary-contact, three-button-operated with open, stop, and close function; located remotely at stage level.
2. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
3. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.
4. Indicator Switches: Provide two (2) indicator switches per unit (1 per set of covers); enclosed type with top plunger actuator.
   a. Indicator Switch Basis of Design: Model BZE6-2RQ by Honeywell, or Equal as approved by smoke vent manufacturer.

2.6 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
1. Installation at Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is constant. Equip hatch with water diverter or cricket on side that obstructs water flow.

B. Glass-Fiber Board Insulation: ASTM C 726, thickness as indicated.

C. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
1. Fasteners for Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153 or ASTM F 2329.

D. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
E. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions.
   1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
   2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
   3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
   4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

C. Heat and Smoke Vent Installation: Install and test heat and smoke vents and their components for proper operation according to NFPA 204.

3.3 TESTING AND ADJUSTING

A. Engage a factory-authorized service representative to perform startup service.
   1. Perform installation and startup checks according to manufacturer's written instructions.
   2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
   1. Adjust exterior doors and components to be weather-resistant.
   2. Adjust seals to provide tight fit around entire perimeter.

C. Adjust limit switches so covers do not over-open, and will close properly from the open position.

D. Lubricate bearings and sliding parts as recommended by manufacturer.

END OF SECTION
SECTION 07 81 00
APPLIED FIREPROOFING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Wet-mix sprayed fireproofing.

1.2 ACTION SUBMITTALS
A. Product Data: For products used.

1.3 INFORMATIONAL SUBMITTALS
A. Manufacturer’s Certificates: Provide certificates from fireproofing manufacturer, for each fireproofing product required, indicating that:
   1. Steel to receive sprayed fireproofing is unprimed or that sprayed fireproofing manufacturer certify primers applied to steel in shop or field are compatible with sprayed-on fireproofing and will not impair its performance under fire exposure for applications indicated, as provided by ASTM E119 test. Include test and other data as evidence. Coordinate with structural steel Sections.
   2. Each fireproofing product complies with specified product requirements and is suitable for use indicated.
   3. Sprayed fireproofing has been completed in accordance with requirements to provide necessary fire resistance ratings. Provide Ratings Certificate.

1.4 QUALITY ASSURANCE
A. Fireproofing Installer: Licensed, qualified, experienced and approved by manufacturer to apply fireproofing materials as specified. Applicator to have been in continuous business for not less than the past 5 years. Applicator shall provide, in writing, names of previous projects, comparable in type and size, successfully completed on time.

1.5 PRECONSTRUCTION TESTING
A. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.
   1. Bond Strength: Test for cohesive and adhesive strength according to ASTM E 736. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   2. Density: Test for density according to ASTM E 605. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with fireproofing.
   4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   5. For materials failing tests, obtain applied-fireproofing manufacturer’s written instructions for corrective measures including the use of specially formulated bonding agents or primers.
PART 2 PRODUCTS

2.1 SPRAY-APPLIED FIRE-RESISTIVE MATERIALS

A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

B. Sprayed-on Fire-resistant Coating: Cementitious fireproofing, Wet-mix setting based type as defined by Underwriters Laboratories and free from asbestos, actinolite, amosite, anthophyllite, chrysotile and tremolite. No mineral fiber fireproofing allowed.
   1. Cementitious Wet Mix Admixtures: Materials (with and without aggregate) which, when mixed in accordance with accompanying instructions forms a slurry or mortar providing properties necessary for conveyance and application to building structures.
   2. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E 119 or UL 263 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Steel members are to be considered unrestrained unless specifically noted otherwise.
      b. UL design listings must state that the loading was determined by Allowable Stress Design Method or Load and Resistance Factor Design Method. UL design listings requiring a load restriction factor are not allowed.

3. VOC Content: Products shall comply with VOC

C. Standard Density: Meeting or exceeding 15 pounds per cubic foot per ASTM E605, no fungal growth per ASTM G21. For concealed locations and in plenum ceilings and above suspended ceilings.
   1. Products and Manufacturers:
      a. Monokote MK-6 by Grace Construction Products.
      b. Pyrolite 15 by Carboline Fireproof Products Division.
      c. Cafco-300 by Isolotek.
      d. Southwest Fireproofing Type 5GP by AD Fire Protection Systems.

D. Auxiliary Fireproofing Materials: Provide type compatible with sprayed-on fireproofing products and substrate that are approved for use indicated by manufacturer of sprayed-on fireproofing, and are approved by nationally recognized testing laboratories or other testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance rated designs indicated.

E. Substrate Primers: Type approved by manufacturer of sprayed-on fireproofing for substrate and for conditions of exposure indicated.

F. Adhesive for Bonding Fireproofing: Type recommended by manufacturer of sprayed-on fireproofing manufacturer.

G. Mixing: Perform mixing and preparation of materials at project using mechanical equipment, in accordance with manufacturer's printed directions to achieve performance criteria specified herein.

PART 3 EXECUTION

3.1 AREA PREPARATION

A. Provide necessary measures for protection of workers and public, as required under regulation of U.S. Occupational Safety and Health Act (OSHA), and applicable local ordinances, and code regulations.
B. Provide protection for workmen applying fireproofing and for other workers who are in vicinity of application of mixing operations. Provide necessary measures for protection of general public and for prevention of air pollution as required. Enclose exterior openings at areas where spray application will be in progress.

C. Provide masking, drop cloths, or other satisfactory covering for materials which are not to receive fireproofing to prevent damage from contamination from overspray or fallout of materials.

3.2 EXAMINATION

A. Examine surfaces to which this work is to be attached or applied and notify Architect if conditions exist which are detrimental to proper and expeditious installation of work. Starting of work shall imply acceptance of substrate for adhesion and performance of work as specified. Substrate is in satisfactory condition if it complies with following:

1. Substrate complies with requirements of section in which substrate and related work is specified and is free of oil, grease, rolling compounds, incomplete primers, loose mill scale, dirt or other foreign substances capable of impairing bond of fireproofing with substrate under conditions of normal use or fire exposure.

2. Objects which will penetrate fireproofing, including clips, hangers, support sleeves and similar items have been securely attached to substrates.

3. Substrates are not obstructed by ducts, piping, equipment and other suspended construction that could interfere with application of fireproofing and until it has dried.

B. Cooperate with coordination and scheduling of work of this section with work of other sections so not to delay job progress.

C. Clips, hangers, supports, sleeves and other attachments to fireproofing bases, as covered under other sections of specifications, are to be placed by other trades prior to application of fireproofing material, where these materials can be anticipated in advance.

D. Ducts, piping or conduit or other suspended equipment that could interfere with uniform application of fireproofing material are to be positioned after application of sprayed fireproofing, unless fireproofing applicator agrees to their installation prior to fireproofing.

E. Prior to application of fireproofing material, ascertain that steel is acceptable to receive fireproofing. Steel shall be free of oil, grease, loose mill scale, or other substance that may impair proper adhesion.

3.3 SURFACE PREPARATION

A. Clean surface to receive sprayed fireproofing to remove mill scale, dirt, grime, oil, grease, dust, loose rust, rolling compounds, incompatible primers and other foreign material which will impair satisfactory bonding of fireproofing to substrate.

B. Cover other work which might be damaged by fallout or overspray of fireproofing materials during application. Provide temporary enclosure as may be required to confine operations, protect environment, and to ensure adequate ambient conditions for temperature and ventilation.

C. Notify Contractor of surface condition which cannot be corrected by normal cleaning methods and requires correction of conditions prior to application of sprayed fireproofing.

3.4 APPLICATION

A. Commencement of application of fireproofing shall be deemed as acceptance by applicator of suitability of surface to receive work and acceptance of responsibility for failure of bond between fireproofing and substrate.
B. Apply spray fireproofing using manufacturer's authorized installer in accordance with manufacturer's directions and instructions and in conformance with city and state codes, regulations and requirements having jurisdiction. Qualified manufacturer's representative shall be present for initial application to guide and assist applicator's personnel.

C. Sprayed Fireproofing: Apply to areas and surfaces which are scheduled to be fireproofed and to proper thicknesses to achieve fireproofing hours.
   1. Control thickness of fireproofing by utilizing workable depth gauge to assure that minimum thickness has been applied.

D. Ventilation: Make provisions to properly dry fireproofing after application. In enclosed areas lacking natural ventilation, provide mechanical air circulation and ventilation.

E. Equipment, Mixing and Application: In accordance with manufacturer's written specification and application instructions. Mechanically control material and water ratio on project site.

F. Qualified Personnel: Provide to supervise application.

G. Bonding Adhesive: Apply to underside of steel roof deck units which do not have concrete topping and where required by appropriate UL Design. Bonding adhesive is optional in other conditions unless recommended by manufacturer of sprayed fire protection material (SFRM). Apply bonding adhesives in accordance with manufacturer's written application instructions.

H. Do not install fireproofing prior to completion of concrete work on steel pan stairs. Apply to underside of roof deck assemblies only after roofing system is complete and roof traffic has ceased.

I. Cracking: No cracking of fireproofing material allowed per UL requirements. Repair cracks at no additional cost to Owner by removing existing fireproofing and reapplying.

3.5 PATCHING, REPAIRING, CLEANING AND PROTECTION

A. Perform patching and repairing of sprayed fireproofing, due to cutting by other trades, by fireproofing applicator. Work shall be paid for by trades that performed cutting, as directed and at no additional cost.
   1. Coordinate installation of fireproofing with other work in order to minimize need for other trades to cut or remove fireproofing. As other trades successively complete installations of their work, maintain protection of structure's fireproofing by patching areas which have been removed or damaged prior to concealment of fireproofing by other work.

B. After completion of fireproofing work, remove equipment and clean walls, floors, equipment, pipes and conduit of over sprayed fireproofing materials.

C. Cleaning: Immediately upon completion of sprayed operations in each containable area, remove over-spray and fall-out materials from surfaces of other work and clean exposed surfaces to remove evidence of soiling.

D. Cure exposed wet-mix fireproofing materials in compliance with fireproofing manufacturer's recommendations to prevent premature drying.

E. Protect fireproofing according to advice of fireproofing manufacturer and installer from damage resulting from construction operations or other causes so that fireproofing will be without damage or deterioration at time of Substantial Completion.

3.6 FIELD QUALITY CONTROL

A. At Owner's option Architect may select, and Owner will pay, independent testing laboratory to sample and verify thickness and density of fireproofing in accordance with provisions of ASTM E605, and cohesion/adhesion as per ASTM E736.
1. Minimum testing as follows:
   a. Randomly Selected Bay: Test each fireproofed element for thickness and density as per ASTM E605 and displacement method per AWCI Tech Manual 12-A, 5.4.5.
   b. Randomly Selected Typical Structural Elements: Test for cohesion/adhesion as per E736.
   c. Perform minimum of 5 tests of each kind.

B. Contractor and sub-contractor for this Section shall cooperate with testing agency in furnishing samples for testing, and other testing agency procedures.
   1. Should tested fireproofing fail to meet performance criteria, remove fireproofing, reinstall and retest at no additional cost to Owner.
   2. Correct unacceptable work and pay for further testing required to prove acceptability of installation.
   3. Patch test areas as required to re-establish fireproofing integrity.

END OF SECTION
SECTION 078400
FIRESTOPPING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
1. Firestop joint sealant and backing, including intumescent elastomeric compounds and sealants.
2. Rigid boards, forms, wraps and accessories.
3. Fiber packing and fiber fill.
4. Wool fiber insulation and fire-safing insulation.
5. Other firestopping as indicated.

1.2 ACTION SUBMITTALS
A. Product Data: Manufacturer's specifications and technical data for each material including the following.
1. Composition and limitations.
2. Manufacturer's installation instructions.
3. Furnish sleeve size schedule indicating size of penetrating item, insulation thickness (where applicable), and minimum annular space requirements.

B. Proposed UL System Drawings - Special Installation Drawings: Prior to starting installation of firestopping, firestopping manufacturer and installer shall review specific conditions applicable for Project, and identify each condition for firestopping and prepare individual U.L. Designs or manufacturers engineering judgements identification numbers, and installation drawings for each condition.
1. Submit 3 Special Installation Drawings for each condition, 1 set for Owner, 1 set for Architect’s File Copy, and 1 set for Building Official.
2. Submit other information as may be requested by Building Official.

1.3 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer.
B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.
C. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: Firm experienced in installation or application of systems similar in complexity to those required for this Project, plus the following.
1. Acceptable to or licensed by manufacturer, State or local authority where applicable.
2. Not less than 2 years’ experience with systems.
3. Successfully completed not less than 5 comparable scale projects using this system.

B. Field Samples: First two applications for each firestopping condition will be reviewed by Owner’s Representative and the Architect, and when accepted by the local Building Official shall become a standard of performance for remaining Work.
1. Correct areas, modify method of application/installation, or adjust as directed by local code official to comply with specified requirements.
2. Maintain field samples accessible to serve as a standard of quality for this Section.

1.5 DELIVERY, STORAGE AND HANDLING
A. Deliver, store and handle to prevent damage, staining and disfigurement in original, new, and unopened packages and containers bearing manufacturer's name and label identifying contents. Do not freeze.
B. Where limited shelf life of product is noted by date on container or packing list, take note and do not use out of date material.

1.6 ENVIRONMENTAL REQUIREMENTS
A. Store firestopping materials out of weather, in cool, dry place, out of direct sunlight, at temperatures below 90 degrees F, not less than 40 degrees F and as recommended by manufacturer.
B. Use of Foam Products: Store unmixed liquid components in original, unopened containers at temperature of 65 to 80 degrees F for 12 hours minimum before use. Use forced air ventilation in areas having less than 2 cubic feet of free air for each pound of liquid mixture being foamed.

1.7 PROJECT CONDITIONS
A. Environmental Requirements: Comply with fireproofing material manufacturer's recommendations for temperature and humidity conditions before, during, and after installation of fireproofing.
B. Ventilation Requirements: Comply with fireproofing material manufacturer's recommendations during and after installation of fireproofing by natural or mechanical means.
C. Sleeves: Unless otherwise called for, sleeves passing through walls, slabs, beams, bridging, columns, shall be minimum of 1/2 inch greater in inside diameter than external diameter of pipe passing through sleeves, or insulation diameter. Verify sleeve size required with manufacturer of firestopping used. Pipe insulation shall be continuous through sleeves. Space between sleeve and pipe or duct and annular opening space shall be provided with a firestop system. Notify Contractor immediately of deviation from above sleeving requirements.
D. Fire Dampers: Firestopping of annular spaces around fire dampers shall be placed before installation of damper's anchoring flanges.

1.8 SEQUENCING
A. Sequence and coordinate application of firestopping with other related work specified in other Sections to comply with the following requirements:
   1. Provide temporary enclosures to prevent deterioration of firestopping for interior applications due to exposure to unfavorable environmental conditions.
   2. Do not install enclosing or concealing construction until after firestopping has been applied, inspected, tested, and corrections have been made to any defective firestopping.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Single Source Responsibility for Materials: Obtain firestopping materials from one manufacturer for entire project.
1. This does not restrict Contractor from subcontracting installation of firestopping to multiple subcontracts, but does require all installers do use the same manufacturer throughout the Project and be licensed by that manufacturer for the installation of firestopping.

B. Acceptable manufacturers and products (FSTOP): Products listed in UL Fire Resistance Directory for UL System involved, that are manufactured by one of the following:
   1. 3M Fire Protection Products.
   2. Hilti Construction Chemicals, Inc.
   3. Grace Construction Products
   4. Nelson Firestop Products
   5. Rectorseal Company
   6. Specified Technologies Inc.
   7. Tremco
   8. US Gypsum Company

2.2 THROUGH-PENETRATION FIRESTOPPING OF FIRE RATED CONSTRUCTION

A. Fire-Test Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those of this specification Section:
   1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, ITS, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
   2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:
      a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
      b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
         1) UL in “Fire Resistance Directory.”
         2) ITS in “Directory of Listed Products.”

B. Fire Rated Construction Design Requirements: Maintain barrier fire resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces or types of construction, at separations required to permit building movement and sound or vibration absorption, and at other construction gaps.

C. Through-Penetration Fire Stopping Schedule: Assembly designs are specified generally under UL system categories by penetrating item. Manufacturers’ product applications must have specific UL system designations. The schedules on the following page indicate which Series of UL Classified Through Penetration Fire Stopping (TPFS) assemblies are acceptable for this Project based on barrier type, construction and penetrant type. The TPFS Series listed are generic in nature; ex: Series C-AJ-2000 includes all designs from 2001 through 2999 from all manufacturers; note that each manufacturer has its own number for tested assemblies. The Contractor will select appropriate TPFS assemblies for each condition encountered.

D. Refer to Schedule at the end of this section.

E. Design of firestopping described by this Section is responsibility of Contractor. Individual through-penetration systems, construction-gap firestopping, through-penetration smoke-stopping, and construction-gap smoke-stopping will be selected by Contractor to meet requirements of Contract Documents and governing codes. Actual selection of individual designs or systems is responsibility of Contractor, and ‘Single Source Responsibility for Materials’ is required.
F. Systems or devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that they conform to the construction type, penetrant type, annular space requirements, and fire rating involved in each separate instance, and that the system be symmetrical for wall applications. Systems or devices must be asbestos-free.

1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the product, or by the use of a separate product included as a part of the UL system or device, and designed to perform this function.

2.3 FIRESTOPPING, GENERAL

A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:
   a. Slag-rock-wool-fiber insulation.
   b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   c. Fire-rated form board.
   d. Fillers for sealants.
2. Temporary forming materials.
5. Steel sleeves.

2.4 FILL MATERIALS

A. General: Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule at the end of Part 3 by reference to the types of materials described in this Article. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.

B. At Noise Critical Spaces: Provide permanently non-hardening systems at penetrations through fire-rated partitions and slabs, and at head of fire-rated partitions.

1. Gun or Trowel-Applied Intumescent Sealant: 3M “CPW-25WB+” or approved equal.
2. Moldable Intumescent Putty: 3M “Moldable Fire Stop” or approved equal.
3. Non-Intumescent Silicone Sealant: 3M “Silicone Fire Stop”, USG “Smokeseal” or approved equal) may be used in lieu of the sealant on foam rod in noise-sensitive fire-rated walls.

C. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

D. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.

E. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
F. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.

G. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

H. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

I. Mortars: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

J. Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.

K. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

L. Silicone Sealants: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
   1. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
   2. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

M. Wiring devices: Ez-Path Fire Rated Pathway by Specified Technologies, Inc.
   1. Fire-rated wiring devices containing intumescent material that allows cable to pass through device and adjusts automatically to cable additions or removals.
   2. F Rating: Equal to rating of barrier in which device is installed.
   3. Capable of allowing a 0 to 100-percent visual fill of cables.
   4. Sufficient size to accommodate quantity and size of electrical wires and data cables required.
   5. Provide with steel wall plates allowing for single or multiple devices to be ganged together.

2.5 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
   1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.

3. Remove laitance and form-release agents from concrete.

4. Do not allow caulks containing solvents to come in direct contact with plastic pipe.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 INSTALLATION

A. Use methods and materials indicated in firestopping systems shown in Referenced Standards.

B. Install penetration seal materials in accordance with instructions in UL Building Materials Directory and in accordance with manufacturer's printed instructions.

C. Install sealant, including forming, packing and other accessory materials to fill opening around services penetrating floors and walls to provide firestops with fire resistance ratings indicated for floor or wall assembly in which penetration occurs.

1. Use masking tape to protect finished substrates and products adjacent to sealant materials.

2. Apply sealant as specified under Section 079200 - Joint Protection, and as recommended by sealant manufacturer; apply bead to depth of 1-1/2 inches to fill void above support, or if mineral wool support is used to depth of 1/2 inch thick. Tool sealant immediately after application and before skin forms.

3. If using foam sealant, immediately after mixing, pour or inject liquid foam into penetration opening, not more than 1/3 full to compensate for expansion during cure or in strict accordance with sealant manufacturer's recommendations. Do not exceed measured snap time of foam sealant. Do not remove dams for 24 hours minimum to allow foam to fully cure.

D. At sleeved pipes or other sleeved penetration, firestop annular space between sleeve and its contained pipe or duct with resilient firestopping sealant system to permit movement of pipe or duct without damage to firestopping sealant.

E. Seal holes and voids made by penetrations to ensure effective fire and smoke barrier.
F. Patch penetrations caused by cutting or presence of unused or abandoned openings or boxes using materials compatible with barrier construction and with fire rating equal to or greater than barrier rating.

G. For plumbing sleeves, construct time rated walls after placement of penetrating materials if possible, and to fit rated construction materials tightly to or directly upon material of penetration.

H. Large Openings: Close unused portions of large openings (annular spaces) made for later installation of pipes and ducts with solid fill equal to barrier rating or with applicable firestopping sealant system.

   1. Where both horizontal dimensions exceed 4 inches in structural floor openings, firestop annular spaces with concrete, or other rated assembly. Provide dowels and reinforcement, within such fill, equal to that specified for slab.

   2. In rated concrete or masonry wall openings where both height and width exceed thickness of rated materials, firestop annular spaces with masonry or other solid fill.

   3. Use fiber fill, solid fill or fiber packing to make up remainder of barrier thickness where required width of firestopping sealant system is less than barrier.

I. Install firestopping materials capable of supporting same loading as floor at floor openings more than four inches in width without penetrating item and subject to traffic or loading.

J. Install firestopping at least equal to barrier fire rating in and around penetrations of floor structures, exterior walls and interior walls noted as time rated fire barriers or smoke barriers.

K. Unused or abandoned openings or boxes or penetrations caused by cutting shall be patched with materials compatible with barrier construction and with fire rating equal to or greater than barrier fire-rating.

L. Use firestopping sealant systems at narrow spaces and at spaces with dimensions less than barrier thickness.

M. Fill void spaces completely with firestopping material.

N. Protect materials from damage on surfaces subject to traffic. Provide firestopping in floors flush with top of slab, sleeve or housekeeping pad.

3.5 IDENTIFICATION

A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:

   Warning – Fire-stop System
   DO NOT DISTURB
   Notify Building Management of Any Damage

   Manufacturer’s System No. ____________
   UL System No: ________________
   Contractor: ____________________
   Date Installed: ________________
   Manufacturer: ________________
3.6 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.
   1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.

B. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued.

C. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

D. Manufacturer's Field Services: Firestopping manufacturer's technical representative shall provide the following field services during application.
   1. Perform a pre-installation examination and acceptance of substrate and voids scheduled for firestopping. Issue report.
   2. Be present at initial start-up for each process. Confirm application techniques. Issue report.
   3. Issue a summary report at completion of installation indicating manufacturer's acceptance of installed system and compliance with UL Design requirements.

3.7 ADJUSTING AND CLEANING

A. Clean up spills of liquid components.

B. Neatly cut and trim materials.

C. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.8 SCHEDULE

THROUGH-PENETRATION UL CLASSIFICATION SYSTEM

<table>
<thead>
<tr>
<th>Fire Stopping Systems</th>
<th>UL Classification System</th>
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<tr>
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<td>Construction Penetrated</td>
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Penetration Firestopping

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<thead>
<tr>
<th>Joint System</th>
<th>Movement Capability</th>
<th>Joint Width range</th>
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<tbody>
<tr>
<td>FF</td>
<td>S/D</td>
<td>0000-4999</td>
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<tr>
<td>WW</td>
<td>S/D</td>
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<tr>
<td>BW</td>
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**Movement Capability**
- S- No movement (Static)
- D- Allows movement (Dynamic)

**Joint Width**
- 0000-0999 Less than or equal to 2 inches
- 1000-1999 Greater than 2 inches and less than or equal to 6 inches
- 2000-2999 Greater than 6 inches and less than or equal to 12 inches
- 3000-3999 Greater than 12 inches and less than or equal to 24 inches
- 4000-4999 Greater than 24 inches

END OF SECTION
SECTION 078443
JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Fire-resistant joint systems (FRJS) for the following:
   1. Head-of-wall joints.
   2. Joints at cold formed exterior wall framing and floor slab.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: For each fire-resistant joint system, show each kind of construction condition in which joints are installed and relationships to adjoining construction. Include fire-resistant joint system design designation of testing and inspecting agency acceptable to authorities having jurisdiction that demonstrates compliance with requirements for each condition indicated.
   1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each fire-resistant joint system configuration for construction and penetrating items.
C. Product Certificates: For each type of fire-resistant joint system, signed by product manufacturer.
D. Qualification Data: For Installer.
E. Compatibility and Adhesion Test Reports: From fire-resistant joint system manufacturer indicating the following:
   1. Materials forming joint substrates have been tested for compatibility and adhesion with fill materials.
   2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
F. Research/Evaluation Reports: For each type of fire-resistant joint system.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain fire-resistant joint systems for each kind of joint and construction condition indicated through one source from a single manufacturer.
B. Preconstruction Compatibility and Adhesion Testing: Submit to fire-resistant joint system manufacturers, for testing indicated below, samples of materials that will contact or affect fill materials.
   1. Use manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of fill materials to joint substrates.
      a. Perform tests under environmental conditions replicating those that will exist during installation.
   2. Submit no fewer than nine pieces of each type of material, including joint substrates, forming materials, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain fire-resistant joint system manufacturer's written instructions for corrective measures, including the use of specially formulated primers.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver fire-resistant joint system products to Project site in original, unopened containers or packages with qualified testing and inspecting agency's classification marking applicable to Project and with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for fire-resistant joint systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fire-resistant joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistant joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate fire-resistant joint systems per manufacturer's written instructions by natural means or, if this is inadequate, forced-air circulation.

1.6 COORDINATION

A. Coordinate construction of joints to ensure that fire-resistant joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistant joint systems.

C. Do not cover up fire-resistant joint system installations that will become concealed behind other construction until Owner's inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: For joints in the following constructions, provide fire-resistant joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly in which fire-resistant joint systems are installed:

1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.
2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
3. Exterior curtain-wall assemblies and fire-resistance-rated floor assemblies.
4. Exterior stud wall assemblies and fire-resistance-rated floor assemblies.

B. Fire Resistance of Joint Systems: Assembly ratings (and movement capabilities) indicated, but with assembly ratings not less than that equaling or exceeding fire-resistance rating of constructions in which joints are located, as determined by UL 2079.

C. Fire Resistance of Perimeter Fire-Containment Systems: Integrity and insulation ratings indicated as determined by UL 2079.
D. Fire-Test-Response Characteristics: Provide fire-resistant joint systems that comply with the following requirements and those specified in "Performance Requirements" Article:
1. Fire-resistance tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for fire-resistant joint systems acceptable to authorities having jurisdiction.
2. Fire-resistant joint systems are identical to those tested per ICBO ES AC30 and are qualified for types of joints and joint movement capabilities indicated in a current Evaluation Report by the ICBO Evaluation Service.
3. (Fire-resistant joint systems are identical to those tested per UL 2079 [and ICBO ES AC30 and are qualified for joint movement capabilities indicated in a current ICBO Evaluation Report by the ICBO Evaluation Service].[ Perimeter fire-containment systems are identical to those tested per UL 2079.] Provide rated systems complying with the following requirements:
   a. Fire-resistant joint system products bear classification marking of qualified testing and inspecting agency.
   b. Fire-resistant joint systems correspond to those indicated by referencing system designations listed by the following:
      1) UL in its "Fire Resistance Directory."

2.2 PRODUCTS AND MANUFACTURERS
A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Basis-of-Design Products: The design for each fire-resistant joint system is based on products named in Part 2 articles. Subject to compliance with requirements, provide either the named products or comparable products by one of the following:
   a. Fire-resistant joint systems:
      1) 3M Fire Protection Products Systems, Inc.
      2) Specified Technologies, Inc.
      3) A/D Fire Protection Systems Inc.
      4) Hilti, Inc.
      5) RectorSeal Corporation (The)
      6) United States Gypsum Company.
   b. Perimeter Fire-Containment Systems:
      1) Specified Technologies Inc.
      2) United States Gypsum Company.
B. Compatibility: Provide fire-resistant joint systems that are compatible with joint substrates, under conditions of service and application, as demonstrated by fire-resistant joint system manufacturer based on testing and field experience.
C. Accessories: Provide components of fire-resistant joint systems, including forming materials, that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by fire-resistant joint system manufacturer and approved by the qualified testing and inspecting agency for systems indicated.

2.3 FIRE-RESISTANT JOINT SYSTEMS
A. Where UL-classified fire-resistant joint systems are indicated, they refer to alphanumeric designations listed in UL's "Fire Resistance Directory" under product Category XHBN.
B. (FRJS-1) Head-of-Wall, Fire-resistant joint system at interior partitions:
   1. Basis-of-Design UL-Classified Product: UL HW-D joint type or similar systems from Intertek to be selected based on actual conditions and subject to approval through submittals. Provide engineering judgment acceptable to Architect and authority having jurisdiction for head of wall conditions where a tested system is not available for the actual conditions.
2. Assembly Rating: 1 hour or 2 hour to be consistent with wall ratings shown on Drawings.
3. Nominal Joint Width: As shown.
4. Movement Capabilities: Class II, 18.75 percent movement in compression and extension.

C. (FRJS-4) Floor-to-Wall: Fire-rated concrete floor assembly to precast structural concrete wall.
   1. Basis-of-Design UL-Classified Product: UL FW-D joint type or similar systems from Omega point laboratory to be selected based on actual conditions and subject to approval through submittals. Provide engineering judgment acceptable to Architect and authority having jurisdiction for conditions where a tested system is not available for the actual conditions.

D. (FRJS-5) Wall-to-Wall, Fire-resistant joint system at interior partitions:
   1. Basis-of-Design UL-Classified Product: UL WW-S joint type or similar systems from Omega point laboratory to be selected based on actual conditions and subject to approval through submittals.

E. (FRJS-6) Floor to Floor, Fire-resistant joint system at interior concrete floors:
   1. Basis-of-Design UL-Classified Product: UL FF-D joint type or similar systems from Omega point laboratory to be selected based on actual conditions and subject to approval through submittals.
   3. For use at slab isolation joints where fire-rating must be maintained, and for other joints that need a fire-rated acoustical sealant.

2.4 PERIMETER FIRE-CONTAINMENT SYSTEMS

A. Where UL-classified perimeter fire-containment systems are indicated, they refer to alphanumeric designations listed in UL's "Fire Resistance Directory" under product Category XHDG.

B. (FRJS-2) Perimeter Fire-Containment System at Curtain Walls
   1. Basis-of-Design System: Provide CW-D type listed by UL or CEJ type listed by Intertek for joint conditions. Provide engineering judgment acceptable to Architect and authority having jurisdiction if a tested, listed system is not available.
   2. Assembly Rating: 1 hour or 2 hour to be consistent with assembly ratings shown on Drawings.
   3. Joint Width: As shown.
   4. Movement Capability: Joint system capable of withstanding total horizontal movement of 25 percent compression and elongation and a total vertical shear movement of 12.5 percent.

C. (FRJS-3) Perimeter Fire-Containment System at Exterior Stud Walls
   1. Basis-of-Design System: Provide CW-S type listed by UL or CEJ type listed by Intertek for joint conditions. Provide engineering judgment acceptable to Architect and authority having jurisdiction if a tested, listed system is not available.
   2. Assembly Rating: 1 hour or 2 hour to be consistent with assembly ratings shown on Drawings.
   3. Joint Width: As shown.
   4. Movement Capability: Joint system capable of withstanding total horizontal movement of 25 percent compression and elongation and a total vertical shear movement of 12.5 percent.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistant joint systems to comply with fire-resistant joint system manufacturer's written instructions and the following requirements:
   1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
   2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistant joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistant joint system from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from fire-resistant joint system materials.
   1. Remove tape as soon as possible without disturbing fire-resistant joint system's seal with substrates.

3.3 INSTALLATION

A. General: Install fire-resistant joint systems to comply with Part 1 "Performance Requirements" Article and fire-resistant joint system manufacturer's written installation instructions for products and applications indicated.

B. Install forming/packing/backing materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

C. Install fill materials for fire-resistant joint systems by proven techniques to produce the following results:
   1. Fill voids and cavities formed by openings and forming/packing/backing materials as required to achieve fire-resistance ratings indicated.
   2. Apply fill materials so they contact and adhere to substrates formed by joints.
   3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect fire-resistant joint systems and to prepare inspection reports.
   1. Inspecting agency will state in each report whether inspected fire-resistant joint systems comply with or deviate from requirements.

B. Proceed with enclosing fire-resistant joint systems with other construction only after inspection reports are issued and inspecting agency has approved installed fire-resistant joint systems.

C. If deficiencies are found, repair or replace fire-resistant joint systems so they comply with requirements.

3.5 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to joints as Work progresses by methods and with cleaning materials that are approved in writing by fire-resistant joint system manufacturers and that do not damage materials in which openings occur.
B. Provide final protection and maintain conditions during and after installation that ensure fire-resistant joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistant joint systems immediately and install new materials to produce fire-resistant joint systems complying with specified requirements.

END OF SECTION
SECTION 079100
PREFORMED JOINT SEALS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Preformed, foam joint seals.
   2. Preformed extruded-silicone joint seals.
B. Related Requirements:
   1. Section 079200 - Joint Sealants: For liquid sealants applied over preformed seals in dual seal systems.

1.2 ACTION SUBMITTALS
A. Product Data: For each preformed joint seal product.
B. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each product exposed to view.
C. Samples for Verification: For each type and color of preformed joint seal required, provide Samples with joint seals in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint seals.
D. Preformed Joint Seal Schedule: Include the following information:
   1. Joint seal location and designation.
   2. Joint width and movement capability.
   3. Joint seal manufacturer and product name.
   4. Joint seal color.

1.3 PROJECT CONDITIONS
A. Joint Substrate Conditions: Do not proceed with joint installation until contaminants capable of interfering with their adhesion are removed from joint substrates.
B. Compatibility and Adhesion Testing: Ascertain joint seal compatibility and adhesion with adjacent materials using laboratory testing procedures.

PART 2 PRODUCTS

2.1 PREFORMED JOINT SEALS
A. Compatibility: Provide joint seal and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by manufacturer, based on testing and field experience.
B. Colors: Colors as selected by Architect from manufacturer's standard colors. Acceptance of sealant will depend on range of standard colors available for selection.
C. Preformed Foam Joint Seal: Manufacturer's standard preformed, precompressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.
1. Manufacturers and Products:
   a. Dayton Superior Specialty Chemicals; Polytite Standard.
   b. EMSEAL Joint Systems, Ltd.; Emseal 25V.
   c. Sandell Manufacturing Co., Inc.; Polyseal.
   d. Schul International, Inc.; Sealtite or Sealtite 50N.
   e. Willseal USA, LLC; Willseal 150 or Willseal 250.

D. Preformed Extruded Silicone Joint Seal: Manufacturer's standard sealant consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.

1. Manufacturers and Products:
   a. Dow Corning Corporation; 123 Silicone Seal.
   b. GE Advanced Materials - Silicones; UltraSpan US1100.
   d. Pecora Corporation; Sil-Span.
   e. Sealex, Inc.; ImmerSeal.

2.2 PREPARATORY MATERIALS

A. Primer: Material recommended by preformed-joint-seal manufacturer for joint substrates indicated.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to preformed joint seal manufacturer, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces, and formulated to promote best adhesion to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with preformed joint seals and surfaces adjacent to joints.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive preformed joint seals, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting preformed-joint seal performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing preformed joint seals to comply with preformed joint seal manufacturer's written instructions and the following requirements:

   1. Remove all foreign material from joint substrates that could interfere with adhesion of preformed joint seal, including dust, paints (except for permanent protective coatings tested and approved for seal adhesion and compatibility by seal manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

   2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimal bond with preformed joint seals. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

      a. Concrete.
      b. Masonry.
      c. Unglazed surfaces of ceramic tile.
      d. Exterior insulation and finish systems.
3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint seals. Nonporous joint substrates include the following:
   a. Metal.
   b. Glass.
   c. Porcelain enamel.
   d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by preformed joint seal manufacturer or as indicated by tests or prior experience. Apply primer to comply with joint seal manufacturer's written instructions. Confine primers to areas of joint seal bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of adhesive or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION

A. General: Comply with preformed joint seal manufacturer’s written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Installation of Preformed, Foam Joint Seals:
   1. Install each length of seal immediately after removing protective wrapping.
   2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.
   3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
   4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer’s written instructions.

C. Installation of Precured, Extruded-Silicone Joint Seals:
   1. Apply masking tape to each side of joint, outside of area to be covered by seal system.
   2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone seal system manufacturer’s written instructions and covering a bonding area of not less than 3/8 inch. Hold edge of sealant bead 1/4 inch inside masking tape.
   3. Press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact with substrate.
   4. Complete installation of seal system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.

3.4 PROTECTION

A. Protect preformed joint seals from damage resulting from construction operations or other causes so seals are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated seals immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION
SECTION 079200
JOINT SEALANTS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Exterior and interior sealants.

1.2 ACTION SUBMITTALS
A. Product Data: For each joint-sealant product.
   1. Submit Manufacturer's certifications that products comply with specified requirements and with local regulations for VOC content.
B. Color Samples:
   1. Samples for Initial Selection: Manufacturer's color charts consisting of actual strips of cured sealants showing the full range of colors available for each product exposed to view.
   2. Samples for Verification: For each kind and color of joint sealant selected, provide Samples with joint sealants in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
C. Product Schedule: Cross-reference products using "SLNT" designation in Part 2 of this Section, with Sealant Schedule in Part 3 of this Section, to locations and applications. Indicate proposed product, product type and color.

1.3 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified testing agency.
B. Sample Warranties: For special warranties.
C. Quality Control Submittals:
   1. Product Test Reports: For each kind of joint sealant.
   2. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
   4. Statement of compliance for compatibility of sealant with adjacent materials and coatings.
   5. Field-Adhesion-Test Reports: For each sealant application tested.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: Engage experienced Installer who has completed joint sealant applications similar in material, design, and extent to that indicated for Project that have resulted in construction with record of successful in-service performance.
B. Provide materials for exterior envelope from a single manufacturer.
C. Compatibility: Verify compatibility of silicone sealant with materials in contact with sealant. Provide list of stone materials and verify that silicone sealant will not stain or damage stone work.
D. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.5 PRECONSTRUCTION TESTING
A. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
6. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials to project site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi component materials.
B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS
A. Weather Conditions: Do not proceed with installation of sealant under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
   1. Proceed with work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength.
   2. Wherever joint width is affected by ambient temperature variation, apply elastomeric sealant only when temperatures are in lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.
B. Joint Width Conditions: Do not proceed with installation of joint sealers when joint widths are less than allowed by joint sealer manufacturer for application indicated.
C. Joint Substrate Conditions: Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.
D. Compatibility and Adhesion Testing: Ascertain sealant compatibility and adhesion with adjacent materials using laboratory testing procedures.

PART 2 PRODUCTS

2.1 SEALANT, GENERAL
A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
B. Sealant Colors: In accordance with approved sealant color schedule.
1. Colors as selected by Architect from manufacturer’s standard colors. Acceptance of sealant will depend on range of standard colors available for selection.

2. Custom Color:

C. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

2.2 POLYURETHANE SEALANT

A. 1-Part Polyurethane Sealants: Polyurethane based one part elastomeric sealant, complying with FS-TT-S-00230C, Type II Class A, with elongation and compression of not less than 25 percent. ASTM C920, Type S, Class 25, Grade NS.

1. Acceptable Manufacturers and Products:
   b. Tremco Incorporated: Dymonic.
   c. Pecora Corporation: Dynatrol I.
   d. Tremco Incorporated: Vulkem 116.

B. 2-Part Polyurethane Sealant for Horizontal Applications: Self-leveling polyurethane based 2 part elastomeric sealant, complying with FS-TT-S-00227E, Type I, Class A, with shore A hardness of not less than 30 and elongation and compression of not less than 25 percent. ASTM C920, Type M, Class 25, Grade P.

1. Acceptable Manufacturers and Products:

2.3 SILICONE SEALANT

A. Low-Modulus Silicone Rubber Sealant: Silicone rubber based, one part neutral cure elastomeric sealant with plus 50 percent to minus 50 percent movement complying with FS-TT-S-001543, Class A, and recommended by manufacturer for joints.

1. Acceptable Manufacturers and Products:
   b. Dow Corning Corporation: 795 Building Sealant.
   c. BASF Building Systems: Sonolastic Omniseal or OmniPlus.
   d. Pecora Corporation: 864 Silicone.
   e. Tremco Construction Division: Spectrem 3.

B. Medium-Modulus Silicone Rubber Sealant: Silicone rubber based, specifically designed for weatherproofing stone or other porous materials, two part moisture cure elastomeric sealant with plus 50 percent to minus 50 percent movement and recommended by manufacturer for stone joints.

1. Acceptable Manufacturers and Products:
   b. Dow Corning Corporation: 756 Building Sealant.
   c. Tremco Construction Division: Spectrem 2.

C. Ultra Low-Modulus Silicone Rubber Sealant: Silicone rubber based, one part neutral cure elastomeric sealant with plus 100 percent to minus 50 percent movement complying with FS-TT-S-001543, Class A.

1. Acceptable Manufacturers and Products:
b. Tremco Construction Division: Spectrem 1.

D. Silyl-Terminated Polyurethane Joint Sealant (STPU): ASTM C920, Type S, Grade NS, Class 12.5, for Us NT.
   1. Product and Manufacturer:
      a. Dymonic FC, by Tremco Incorporated;
      b. Dyanflex SC, by Pecora Corporation

E. Silicone Sealant, Mildew-Resistant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.
   1. DAP Inc.; 100 percent Silicone Kitchen and Bath Sealant.
   2. Dow Corning Corporation; Dow Corning 786.
   3. GE Silicones; a division of GE Specialty Materials; Sanitary 1700.
   5. Pecora Corporation; Pecora 898 Sanitary Silicone Sealant.
   6. Tremco Incorporated; Tremsil 600 White.

2.4 ACRYLIC SEALANT

A. Acrylic Sealants: General purpose, paintable acrylic-emulsion sealant. Caulk with approximately 12-1/2 percent elongation complying with ASTM C834.
   1. Acceptable Manufacturers and Products:
      a. Tremco Incorporated: Acrylic Latex 834.
      b. BASF Building Systems: Sonolac.

2.5 JOINT SEALANT BACKING

A. Joint Sealant Backer Rod Manufacturers:
   1. Denver Foam, Backer Rod Manufacturing, Inc.
   2. Sonneborn Sonolastic, BASF Building Systems.
   3. Construction Foam Products, Nomaco Inc..

B. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

C. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.6 PREPARATORY MATERIALS

A. Joint Primer: Non-staining type recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive type recommended by sealant manufacturer; compatible with joint forming materials.
PART 3 EXECUTION

3.1 EXAMINATION

A. Examine joint surfaces, backing, and anchorage of units forming sealant rabbet, and conditions under which sealant work is to be performed. Do not proceed with sealant work until unsatisfactory conditions have been corrected.

3.2 JOINT SURFACE PREPARATION

A. Clean joint surfaces immediately before installation of sealant. Remove dirt, insecure coatings, moisture and other substances which would interfere with bond of sealant.

B. Etch concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's printed instructions indicate that alkalinity does not interfere with sealant bond and performance. Etch with 5 percent solution of muriatic acid; neutralize with dilute ammonia solution, rinse thoroughly with water and allow to dry before sealant application.

C. Roughen joint surfaces on vitreous coated and similar non-porous materials, wherever sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce dull sheen.

D. Ensure that joint forming materials are compatible with sealant.

E. Examine joint dimensions and size materials to achieve required width/depth ratios. Use joint filler to achieve required joint depths, to allow sealants to perform properly.

3.3 SEALANT APPLICATION

A. Apply sealant in accordance with manufacturer's printed instructions. Perform work in accordance with ASTM C804.

B. Prime or seal joint surfaces. Do not allow primer/sealer to spill or migrate onto adjoining surfaces.

C. Install sealant backer rod for liquid elastomeric sealant, except where recommended to be omitted by sealant manufacturer for application shown.

D. Install bond breaker tape wherever required by manufacturer's recommendations to ensure that elastomeric sealant will perform properly.

E. Employ only proven installation techniques, which will ensure that sealant will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete “wetting” of joint bond surfaces equally on opposite sides.

1. Except as otherwise indicated, fill sealant rabbet to slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between horizontal surface and vertical surface, fill joint to form slight cove, so that joint will not trap moisture and dirt.

F. Install sealant to depth as shown or, if not shown, as recommended by sealant manufacturer but within following general limitations, measured at center (thin) section of bead:

1. For sidewalks, pavements and similar joints sealed with elastomeric sealant and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but not more than 5/8 inch deep nor less than 3/8 inch deep.

2. For normal moving joints sealed with elastomeric sealant, but not subject to traffic, fill joint to depth equal to 50 percent of joint width, but not more than 1/2 inch deep nor less than 1/4 inch deep.

G. Interior joints not subject to movement, these are:

1. Gypsum board to masonry joints.
2. Gypsum board to hollow metal joints.
3. Gypsum board to concrete joints.

H. Do not allow sealant or compounds to overflow or flow onto adjoining surfaces, or to migrate into voids of adjoining surfaces including rough texture surfaces. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either primer/sealer or sealant.

I. Remove excess and spillage of sealant promptly as work progresses. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes.

J. Rope Wicks: Where wicks for weeping masonry cavity occur in sealant, cut wick flush with sealant face and do not seal wick ends.

3.4 PROTECTION AND CLEANING

A. Protect joint sealers during and after curing period from contact with contaminating operations or other causes so that they are without deterioration or damage at time of Substantial Completion.

1. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

B. Clean off excess sealant or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

3.5 JOINT-SEALANT SCHEDULE

A. General: Provide sealant where indicated (SLNT) or as required to achieve a weather-tight assembly.

1. Joint-Sealant Colors: As selected by Architect from manufacturer’s full range of colors.

2. The following schedule is not intended to be all-inclusive and some may not be applicable to this Project.

B. Exterior Joints:

1. Horizontal Surfaces Subject to Traffic:
   a. Joint Locations:
      1) Isolation and contraction joints in cast-in-place concrete slabs.
      2) Joints between plant-precast architectural concrete paving units.
      3) Tile control and expansion joints.
      4) Joints between different materials listed above.
      5) Other joints as indicated.
   b. 2-Part polyurethane sealant, self-leveling, traffic grade, Class 25.

2. Horizontal Surfaces Subject to Traffic and Water Immersion:
   a. Polyurethane sealant, submersible, multi-component, self-leveling, traffic grade.

3. Vertical Surfaces and Horizontal Surfaces Not Subject to Traffic:
   a. Joint Locations:
      1) Construction joints in cast-in-place concrete.
      2) Control and expansion joints in unit masonry.
      3) Joints between metal panels.
      4) Joints between different materials listed above.
   b. Silicone single component, nonsag, neutral curing, Class 25.
   c. Silicone multicomponent, nonsag, neutral curing.

4. Perimeter joints between materials listed above and frames of doors, windows, and louvers:
   a. Silicone multicomponent, nonsag, neutral curing.

5. Vertical Surfaces and Horizontal Surfaces Not Subject to Traffic:
   a. Joint Locations:
      1) Unit Masonry Glazed Aluminum Framing System.
2) Metal Panel to Glazed Aluminum Framing System.
   b. Silicone Ultra Low-Modulus Silicone Rubber Sealant.

C. Interior Joints:

1. Horizontal Surfaces Subject to Traffic:
   a. Joint Locations:
      1) Isolation joints in cast-in-place concrete slabs.
      2) Other joints as indicated.
   b. 2-Part polyurethane sealant, self-leveling, traffic grade, Class 25.

2. Vertical Surfaces and Horizontal Surfaces Not Subject to Traffic: Acrylic-based.
   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Perimeter joints of exterior openings where indicated.
   c. Tile control and expansion joints.
   d. Vertical joints on exposed surfaces of interior unit masonry, concrete, walls, and partitions.
      1) (CMU) to (CMU): Low modulus silicone sealant.
   e. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
   f. Joints between plant-precast structural concrete units.
   g. Other joints as indicated.

   a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   b. Tile control and expansion joints where indicated.
   c. Other joints as indicated.


END OF SECTION
SECTION 079513
EXPANSION JOINT COVER ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Joint cover assemblies (EXP JT).

1.2 ACTION SUBMITTALS
A. Shop Drawings: Submit for each item of work in accordance with Section 013300. Indicate joint device profiles, dimensions, locations in the Work, affected adjacent construction, anchorage devices, available colors and finish, and locations of splices.
B. Samples: Submit samples in accordance with Section 013300. Submit one 12 inch long sample of each joint, in size illustrating profile, dimension, color, and finish selected.
C. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
   1. Manufacturer and model number for each expansion joint cover assembly.
   2. Expansion joint cover assembly location cross-referenced to Drawings.
   3. Nominal, minimum, and maximum joint width.
   4. Movement direction.
   5. Materials, colors, and finishes.
   6. Product options.

1.3 QUALITY ASSURANCE
A. Installer Qualifications: Installer of expansion control joints shall be approved by manufacturer of control joints.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION AND PERFORMANCE REQUIREMENTS
A. Expansion Joint Systems: Provide expansion control systems of design, basic profile, materials, and operation indicated. Provide units with capability to accommodate variations in adjacent surfaces.
   1. Furnish units in longest practicable lengths to minimize field splicing. Install with hairline mitered corners where expansion control systems change direction or abut other materials.
   2. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion control systems.
   3. Source Limitations: Obtain each expansion control systems from single source from single manufacturer.
B. Coordination: Coordinate installation of exterior wall and soffit expansion control systems with roof expansion control systems to ensure that wall transitions are watertight. Roof expansion joint assemblies are specified elsewhere.
C. Fire Performance Characteristics: Where indicated, provide expansion joint cover assemblies identical to those of assemblies whose fire resistance has been determined per UL 2079, NFPA 251, or ASTM E119 and E814 including hose stream test at full-rated period by nationally recognized testing and inspecting organization or by another means, as acceptable to authorities having jurisdiction.

2.2 MANUFACTURERS
A. Manufacturers: Provide Basis of Design or equivalent products by one of the following Manufacturers:
   2. MM Systems Corporation
   3. Balco Inc.
   4. Watson-Bowman-Acme Corporation
   5. Pawling Corporation
   7. Nystroms, Inc.
   8. InPro Corporation

2.3 MATERIALS
A. Aluminum: ASTM B 221, Alloy 6063-T5 for extrusions; ASTM B 209, Alloy 6061-T6 for sheet and plate. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
B. Stainless Steel: ASTM A 240 or ASTM A 666, Type 304 for plates, sheet, and strips. Remove tool and die marks and stretch lines or blend into finish.

2.4 SEALS AND BARRIERS
A. Extruded Preformed Seals: Single or multicellular elastomeric profiles as classified under ASTM D2000, designed with or without continuous, longitudinal, internal baffles. Formed to fit compatible frames.
   1. Resilient Filler: Elastomer; exhibiting Shore A hardness of durometer 65A.
   2. Color: As selected from manufacturer's standard colors.
B. Elastomeric Seals: ASTM E 1783; preformed elastomeric membranes or extrusions to be installed in metal frames.
C. Compression Seals: ASTM E 1612; preformed elastomeric extrusions having an internal baffle system and designed to function under compression.
D. Cellular Foam Seals: Extruded, compressible foam designed to function under compression.
E. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to meet performance criteria for required fire-resistance rating.
F. Moisture Barrier: Flexible elastomeric material, minimum 45 mils thick.

2.5 ACCESSORIES
A. Accessories: Manufacturer's standard anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.
B. Elastomeric Concrete: Modified epoxy or polyurethane extended into a prepackaged aggregate blend, specifically designed for bonding to concrete substrates.
C. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 PREPARATION

A. Deliver inserts and rough-in frames to job site at appropriate time for building-in. Provide templates and rough-in measurements as required.

B. Provide spall-free level, bottom blockout parallel to deck surface in concrete to dimensions indicated. Blockout shall be open and dry.

C. Before starting work notify Architect in writing of conflicts detrimental to installation or operation of units.

3.2 INSTALLATION

A. Install components in accordance with reviewed shop drawings and manufacturer's printed instructions.

B. Prepare and place expansion joints in accordance with manufacturer's printed instructions.

C. Install expansion joints true, plumb and level, flush with adjacent surfaces.

D. Securely and rigidly anchor to substrate to prevent movement or misalignment.

E. Installation of Fire Barriers: Install fire barriers in accordance with federal, state, and local building codes using manufacturer's recommended procedures. Install transition and end joints to provide continuous fire resistance and in accordance with manufacturer's instructions.

F. Do not remove strippable protective material until finish work in adjacent areas is complete. Protective material is removed, clean exposed metal surfaces to comply with manufacturer's instructions.

G. Protect finished installation in accordance with Section 017700. Prevent traffic from crossing joints until entire assembly has cooled and is firmly cured.

END OF SECTION
SECTION 081113
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Standard and custom hollow metal doors and frames.
2. Steel sidelight, borrowed lite and transom frames.
3. Louvers installed in hollow metal doors.
4. Light frames and glazing installed in hollow metal doors.

B. Related Sections:

1. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
2. Division 08 Section "Flush Wood Doors".
3. Division 08 Section "Glazing" for glass view panels in hollow metal doors.
4. Division 08 Section "Door Hardware".
5. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.
6. Division 28 Section "Access Control" for access control devices installed at door openings and provided as part of a security access control system.

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
6. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
7. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
11. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
16. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
17. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.

B. Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.

C. Shop Drawings: Include the following:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of anchorages, joints, field splices, and connections.
6. Details of accessories.
7. Details of moldings, removable stops, and glazing.
8. Details of conduit and preparations for power, signal, and control systems.

D. Samples for Verification:

1. Samples are only required by request of the architect and for manufacturers that are not current members of the Steel Door Institute.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.

B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".
C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL10C (neutral pressure at 40" above sill) or UL 10C.

1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.

2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

   a. Smoke “S” Label: Doors to bear “S” label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.

D. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.

E. Energy Efficient Exterior Openings: Comply with minimum thermal ratings, based on ASTM C1363. Openings to be fabricated and tested as fully operable, thermal insulating door and frame assemblies.

1. Thermal Performance (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM C1363 and meet or exceed the following requirements:
   a. Door Assembly Operable U-Factor and R-Value Ratings: U-Factor 0.29, R-Value 3.4, including insulated door, thermal-break frame and threshold.

2. Air Infiltration (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM E283 to meet or exceed the following requirements:
   a. Rate of leakage of the door assembly shall not exceed 0.25 cfm per square foot of static differential air pressure of 1.567 psf (equivalent to 25 mph wind velocity).

F. Sound Transmission Class (STC) Rated Doors: Provide sound transmission class rated doors fabricated as sound-reducing types with testing according to ASTM E 90, and classifications according to ASTM E 413. Submit manufacturer’s written results of STC ratings from testing performed by a qualified independent testing agency for sound resistant doors.

G. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section “Project Meetings” with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. MATERIALS ARE SPECIFIED IN ACCORDANCE WITH THE PREMIER/ASSA ABLOY GPO CONTRACT #PP-FA-663.

B. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from a SDI Certified manufacturer:

1. CECO Door Products (C).
2. Curries Company (CU).
3. Pioneer Industries (PI).
2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.3 HOLLOW METAL DOORS

A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.

B. Exterior Doors (Energy Efficient): Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A924 A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model, ANSI/SDI A250.4 for physical performance level, and HMMA 867 for door construction.

1. Design: Flush panel.
2. Core Construction: Foamed in place polyurethane and steel stiffened laminated core with no stiffener face welds, in compliance with HMMA 867 "Laminated Core".
   a. Provide 22 gauge steel stiffeners at 6 inches on-center internally welded at 5" on-center to integral core assembly, foamed in place polyurethane core chemically bonded to all interior surfaces. No stiffener face welding is permitted.
   b. Thermal properties to rate at a fully operable minimum U-Factor 0.29 and R-Value 3.4, including insulated door, thermal-break frame and threshold.
3. Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), Minimum 16 gauge (0.053 inch - 1.3-mm) thick steel, Model 2.
4. Vertical Edges: Vertical edges to be mechanically interlocked with hairline seam. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
5. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
6. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9".
7. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

C. Interior Doors: Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Design: Flush panel.
2. Core Construction: Manufacturer's standard kraft-paper honeycomb, or one-piece polystyrene core, securely bonded to both faces.
   a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

3. Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), minimum 16 gauge (0.053-inch - 1.3-mm) thick steel, Model 2.
4. Vertical Edges: Vertical edges to have the face sheets spot welded and filled full height with an epoxy filler. Welds are to be ground, filled and dressed smooth. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
5. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet.
6. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
7. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Manufacturers Basis of Design:
   1. Curries Company (CU) - Polystyrene Core - 707 Series (interior doors).

E. Acceptable Manufacturers:
   1. Curries Company (CU)
   2. CECO Industries (CE)
   3. Steelcraft Doors and Frames (ST)

2.4 HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Thermal Break Frames: Subject to the same compliance standards and requirements as standard hollow metal frames. Tested for thermal performance in accordance with NFRC 102, and resistance to air infiltration in accordance with NFRC 400. Where indicated provide thermally broken frame profiles available for use in both masonry and drywall construction. Fabricate with 1/16" positive thermal break and integral vinyl weatherstripping.

   1. Frames: Minimum 14 gauge (0.067-inch -1.7-mm) thick steel sheet.
   2. Manufacturers Basis of Design:

D. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.
1. Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet for door openings up to 48 inches in width.
2. Frames: Minimum 14 gauge (0.067-inch -1.7-mm) thick steel sheet for door openings greater than 48 inches in width.
3. Manufacturers Basis of Design:
   a. Curries Company (CU) - CM Series.
   b. Curries Company (CU) - M Series.

E. Acceptable Manufacturers:
1. Curries Company (CU)
2. CECO Industries (CE)
3. Steelcraft Doors and Frames (ST)

F. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.

G. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:
1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.

B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.

C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.6 LIGHT OPENINGS AND GLAZING

A. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator's shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.

B. Moldings for Glazed Lites in Doors and Loose Stops for Glazed Lites in Frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.
2.7 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.8 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.

C. Hollow Metal Doors:

1. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.
2. Glazed Lites: Factory cut openings in doors with applied trim or kits to fit. Factory install glazing where indicated.
3. Astragals: Provide overlapping astragals as noted in door hardware sets in Division 08 Section "Door Hardware" on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
4. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge strap for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
5. Electrical Raceways: Provide hollow metal doors to receive electrified hardware with concealed wiring harness and standardized Molex™ plug connectors on both ends to accommodate up to twelve wires. Coordinate connectors on end of the wiring harness to plug directly into the electrified hardware and the through-wire transfer hardware or wiring harness specified in hardware sets in Division 08 Sections "Door Hardware" and "Access Control Hardware". Wire nut connections are not acceptable.

D. Hollow Metal Frames:

1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
2. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
   a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreaders are for bracing only and are not to be used to size the frame opening.
3. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge straps for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
4. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.

5. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.

6. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.

7. Jamb Anchors: Provide number and spacing of anchors as follows:
   a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
      1) Two anchors per jamb up to 60 inches high.
      2) Three anchors per jamb from 60 to 90 inches high.
      3) Four anchors per jamb from 90 to 120 inches high.
      4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
   b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
      1) Three anchors per jamb up to 60 inches high.
      2) Four anchors per jamb from 60 to 90 inches high.
      3) Five anchors per jamb from 90 to 96 inches high.
      4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
      5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.

8. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".

9. Bituminous Coating: Where frames are fully grouted with an approved Portland Cement based grout or mortar, coat inside of frame throat with a water based bituminous or asphaltic emulsion coating to a minimum thickness of 3 mils DFT, tested in accordance with UL 10C and applied to the frame under a 3rd party independent follow-up service procedure.

E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.
2.9 STEEL FINISHES

A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.

   I. Shop Primer: Manufacturer’s standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.

C. Tolerances shall comply with SDI-117 “Manufacturing Tolerances Standard Steel Doors and Frames.”

D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer’s written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.

   I. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and
secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.

3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.

4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:
   a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
   b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
   c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Field Glazing: Comply with installation requirements in Division 08 Section “Glazing” and with hollow metal manufacturer’s written instructions.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

END OF SECTION 081113
SECTION 08 14 00
FLUSH FLUSH WOOD DOORS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Interior solid core flush wood doors:
      a. Fire-rated flush wood doors.
      b. Non-rated flush wood doors.
   2. Shop-priming of field-painted doors.
   3. Factory finishing.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.
B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
   1. Dimensions and locations of blocking.
   2. Dimensions and locations of mortises and holes for hardware.
   3. Dimensions and locations of cutouts.
   4. Undercuts.
   5. Requirements for veneer matching.
   6. Doors to be factory finished and finish requirements.
   7. Fire-protection ratings for fire-rated doors.
C. Samples:
   1. Wood Veneer with Transparent Finish: Provide set of 3 samples, approximately 8 by 10 inches, showing typical range of color and grain to be expected in finished work.

1.3 INFORMATIONAL SUBMITTALS
A. Certification: Submit certification that doors and frames comply with NFPA 252 or UL-10.
B. Field Conditions Reports.

1.4 DELIVERY, STORAGE, AND HANDLING
A. Protect wood doors from damage, dust and dirt. Do not deliver, receive, store or install wood doors until storage and installation areas are conditioned in accordance with requirements and recommendations of NAAWS.
B. Comply with requirements of referenced standards and with manufacturer's written instructions.
C. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting
   1. Use opaque plastic sheeting for natural finished doors.
   2. Mark each door on top and bottom edges with opening number used on Shop Drawings
D. Stack wood doors as recommended by door manufacturer.
1.5 FIELD CONDITIONS

A. Environmental Requirements: Use permanent HVAC system or provide temporary systems and controls to establish and maintain site conditions complying with specified requirements.
   1. Do not deliver, receive, store or install woodwork until building is enclosed, wet work is complete, and temporary or permanent HVAC systems are operating in areas where woodwork is stored and installed, and are maintaining temperature and relative humidity at occupancy levels and within the following ranges during the remainder of the construction phase:
      a. Temperature Range: Between 60 and 90 deg F.
      b. Relative Humidity Range: Between 25 and 55 percent.

2. Fluctuation of Temperature and Relative Humidity Levels:
   a. Do not exceed 15 percent fluctuation over any portion of a 7-day period and not to exceed 25 percent fluctuation over any portion of a 28-day period.
   b. Maintain operation and control of heating, cooling, humidity, ventilation, temporary barriers and similar facilities continuously on a 24-hour basis to avoid rapidly fluctuating ambient levels.

B. Site Conditions Report: Monitor temperature and relative humidity in areas where woodwork is stored and installed at Project site. Record temperature and relative humidity prior to delivery, throughout storage period and installation, and after installation until time of Substantial Completion. Report recorded values in accordance with Submittals requirements.

1.6 WARRANTY

A. Special Warranty: Signed by Manufacturer, Installer, and Contractor, in which Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
      b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
   2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   1. Provide gasket as required by door manufacturer in compliance with UL10C, Category A.
   2. Oversized Fire-Rated Door Assemblies: For door assemblies exceeding sizes of tested assemblies, provide oversize fire door label or certificate of inspection, from a testing and inspecting agency acceptable to authorities having jurisdiction, stating that doors comply with requirements of design, materials, and construction.
   3. Fire-Rated Wood Door and Frame Assemblies: Provide wood doors and frames which are identical in materials and construction to units tested in door and frame assemblies in accordance ASTM E152 and which are labeled and listed for ratings indicated by UL or other testing and inspection agency acceptable to authorities having jurisdiction.
   4. Temperature Rise Rating: [Where indicated] [At vertical exit enclosures and exit passageways], provide doors which have Temperature Rise Rating of 450 degrees F maximum in 30 minutes of fire exposure.
B. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.

### 2.2 WOOD DOORS, GENERAL

A. Quality Standards: Provide wood doors fabricated and installed in accordance with specified Grade classification of the *North American Architectural Woodwork Standards, Adopted and Published jointly by Architectural Woodwork Institute, Architectural Woodwork Manufacturer’s Association of Canada and Woodwork Institute - Current Edition* (NAAWS)

1. Comply with NAAWS Premium Grade, except where more stringent requirements are indicated in the Contract Documents.

B. Material Requirements for Sustainability:

1. Low-Emitting Adhesives and Binders: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
2. Particleboard: Straw-based particleboard complying with ANSI A208.1, Grade LD-2 or M-2, except for density.

C. Source Limitations: Obtain flush wood doors from single manufacturer.

D. Manufacturers:

1. Algoma Group.
2. Buell Door Co..
3. Ideal Wood Products.
4. Weyerhauser Co..

E. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.


1. Screw Withdrawal: 700 lbf at faces, 400 lbf at edges.

G. Mineral-Core for Fire-Rated Doors: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.

2. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

H. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering. Faces are bonded to core using a hot press.

I. Adhesives: Type I per WDMA TM-6, waterproof.

J. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.

1. Facing and Crossband Adhesive: Type 1 waterproof.
2. Door Construction: Type 2.

K. Lite Kit: Provide frames that are flush to face of door, in species of wood to match face of door or veneer wrapped mineral core for fire rated doors.

### 2.3 DOOR FACING AND FINISHES

A. Wood-Veneer Faced Doors with Transparent Finish: NAAWS Premium grade, with Grade AA faces, 1/50 inch thick before final sanding.

1. Wood Species, Cut and Finish: Rift-Sliced Red Oak (WD-1), as specified in Section 064000 - Architectural Woodwork.
2. Veneer Matching:
   b. Assembly of Veneer Leaves on Door Faces: Balance match.
   c. Pair and Set Match: Provide for doors hung in same opening.
   d. Room Match: Match door faces within each separate room or area of building.
   e. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Section 064000 - Architectural Woodwork.
   f. Exposed Vertical and Top Edges: Same species as faces.

3. Transparent Finish: Shop-applied, NAAWS Premium Grade, System 5 Conversion Varnish.
   a. Shop Priming for Transparent Finish: Shop prime faces and all four edges with stain, other required pretreatments, and first coat of transparent finish. Seal edges of cutouts and mortises with first coat of finish.

B. Doors with Opaque Painted Finish: (WD-5) as specified in Section 064000 - Architectural Woodwork.
   1. Shop Priming of Field-Applied Opaque Finish: Shop prime faces, all four edges, edges of cutouts, and mortises with one coat of wood primer specified in Section 099000 - Painting.

2.4 FABRICATION

A. Fabricate wood doors in accordance with requirements of specified NAAWS Grade.

B. Fabricate Work of this Section using materials, methods and quality control procedures necessary for installed units to withstand dimensional changes that can be expected resulting from temperature and humidity variations at project location when interior spaces do not have humidity control. Seal each surface to help mitigate dimensional change resulting from temperature and humidity variations.

C. Fabricate and label fire-rated doors in accordance with requirements of Underwriters’ Laboratories (UL), UL-10C, Category A Positive Pressure, with intumescent required for compliance contained within the door (concealed) and requiring no additional installation of intumescent products.

D. Fabricate doors with hardware blocking as follows:
   1. Provide head and sill rails on all doors.
   2. Provide adequate blocking for doors specified with concealed overhead stops and surface mounted closers.
   3. Provide lock-block at fire-rated, mineral core doors at latch side only.
   4. Provide cross blocking only when exit devices are specified for door.
   5. Provide hook block for pivots, or when floor bolts are specified under Section 087100 - Door Hardware.

E. Provide doors with minimum 1-1/4 inch thick edge strips, of wood species to match face veneers except as required for UL rating.

F. Make cut-outs and provide stops for glass and louvers. Seal cut-outs prior to installation of moldings.
   1. For full light doors: Provide cut out from flush wood door, with vertical grain direction.

G. Bevel strike edge of single acting doors 1/8 inch in 2 inches. Radius strike edge of double-acting swing doors 2-1/8 inches.

H. Prepare doors to receive hardware. Refer to Section 087100 – Door Hardware and NFPA 80 for hardware requirements including UL-10C.
1. Factory pre-machine doors for all mortised hardware, including pilot holes for hinge screws and lock fronts.
2. Prefit and bevel to net opening size less approximately 3/16 inch in width and provide 1/4 inch clearance above finished floor, unless otherwise indicated on drawings.

I. Fire-Rated Pair of Doors; greater than 20 minute: If astragal is required, to comply with fire rated labeling requirements for pairs of fire rated doors, provide door manufacturer's standard tested astragal.
   1. Shop apply astragals.
   2. Shop apply matching veneer wrap to conceal metal astragal at wood faced doors.
   3. Install concealed intumescent seals per UL-10C where required by code.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examination and Acceptance of Conditions: Before proceeding with installation, examine openings to receive wood doors and other conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
   2. Material Moisture Content and Environmental Requirements: Comply with recommendations of NAAWS.
      c. Do not install woodwork that has not been conditioned to average prevailing humidity conditions in installation areas.
   3. Reject doors with defects.
   4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions. Architectural woodwork Installer shall approve substrate prior to installation.

3.2 INSTALLATION
A. Hardware: Prepare doors to receive hardware in accordance with Section 087100 - Door Hardware.
B. Install doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.
   1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
   2. Install smoke- and draft-control doors according to NFPA 105.
C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.
   1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold.
   2. Comply with NFPA 80 for fire-rated doors.
   3. Factory-Finished, Job-Fitted Doors: Restore finish before installation if fitting or machining is required at Project site.
D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
E. Wood Doors with Sound Seals: Undercut of door shall be 3/8-inch maximum for doors to be equipped with automatic door bottoms (sound seals).
F. Ensure that smoke and sound gaskets are in-place before prefinished door installation.

### 3.3 INSTALLED WORK

A. Damaged or Non-Compliant Work: Remove and replace materials that are damaged or do not comply with requirements.
   1. Damaged finish may be repaired or refinished if resulting repair work complies with requirements and shows no evidence of repair or refinishing.

B. Adjusting: Adjust movable components to operate safely, smoothly, easily, and quietly, free from binding, warp, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range, and without binding or damaging assembly components.
   1. Lubricate hardware and moving parts in accordance with Manufacturer’s written instructions.
   2. Operation: Rehang or replace doors that do not swing or operate freely.

C. Cleaning: Clean and maintain installed work as frequently as necessary through the remainder of the construction period.

D. Protection: Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
   1. At clear finished doors, do not partially cover door surfaces with paper, cardboard, or other opaque covering that will create uneven aging of wood veneer.

E. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION
SECTION 081433
STILE AND RAIL WOOD DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Exterior stile and rail wood doors.
   2. Interior stile and rail wood doors.
   3. Wood door frames.
   4. Factory fitting stile and rail wood doors to frames and factory machining for hardware.
   5. Factory finishing.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:
   1. Details of construction and glazing.
   2. Door frame construction.
   3. Factory-machining criteria.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data, including those for stiles, rails, panels, and moldings (sticking); and other pertinent data, including the following:
   1. Door schedule indicating door and frame location, type, size, fire protection rating, and swing.
   2. Door elevations, dimensions and location of hardware, lite locations, and glazing thickness.
   3. Details of frame for each frame type, including dimensions and profile.
   4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
   5. Dimensions and locations of mortises and holes for hardware.
   6. Clearances and undercuts.
   7. Requirements for veneer matching.
   8. Doors to be factory finished and application requirements.

C. Samples for Initial Selection: For factory-finished doors and frames.

D. Samples for Verification:
   1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.
   2. Corner sections of doors, approximately 8 by 10 inches, with door faces and edges representing actual materials to be used.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality control reports.

1.4 CLOSEOUT SUBMITTALS.

A. Special warranties.
B. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.
B. Package doors individually in opaque plastic bags or cardboard cartons.
C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity levels designed for building occupants for the remainder of construction period.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace doors[ and frames] that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Delamination of veneer.
      b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
      c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
   2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors and frames.
   3. Warranty shall be in effect during specified period of time from date of Substantial Completion.

PART 2 PRODUCTS

2.1 STILE & RAIL WOOD DOORS

A. Source Limitations: Obtain stile and rail wood doors from single manufacturer.
B. Products and Manufacturers: Provide Basis of Design or equivalent as approved by Architect by one of the following Manufacturers:
   1. Algoma Group.
   2. Buell Door Co..
   3. Ideal Wood Products.
   5. Weyerhauser Co..
C. Basis of Design: Aspiro Series, Harring Model A112A by Masonite Architectural.
D. Stile and Rail Wood Panel Doors: Exterior doors, 12-panel design, complying with WDMA I.S. 6A, and with other requirements specified.
   1. Performance Grade: Extra Heavy Duty.
   2. Grade: Premium.
3. Finish: Transparent.
5. Stile and Rail Construction: Veneered, structural composite lumber. Select veneers for similarity of grain and color, and arrange for optimum match between adjacent pieces.
   a. Use veneers not less than 1/16 inch thick.
6. Raised-Panel Construction: Veneered, wood-based panel product with mitered, raised rims made from matching clear lumber.
   a. Particleboard: Wood-based particleboard; ANSI A208.4, Grade LD-2 as required to meet WDMA Performance Duty level specified without added blocking.
7. Stile and Rail Widths: As indicated on Drawings.
9. Molding Profile (Sticking): As selected by Architect from manufacturer’s full range.
10. Use only materials that comply with referenced standards and other requirements specified.
   a. Assemble exterior doors, including components, with wet-use adhesives complying with ASTM D5572 for finger joints and with ASTM D5751 for joints other than finger joints.
   b. Assemble interior doors, including components, with either dry-use or wet-use adhesives complying with ASTM D5572 for finger joints and with ASTM D5751 for joints other than finger joints.
11. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S. 6A and grade specified.

2.2 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels unless otherwise indicated:
   1. Clearances:
      a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
      b. Provide 1/2 inch from bottom of door to top of decorative floor finish or covering.
      c. Where threshold is shown on Drawings or scheduled, provide not more than 3/8 inch from bottom of door to top of threshold.
   2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
B. Fabricate stile and rail wood doors in sizes indicated for field fitting.
C. Factory machine doors for hardware that is not surface applied.
   1. Locate hardware to comply with DHI-WDHS-3.
   2. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
   3. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
   4. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
D. Glazed Openings: Factory install glazing in doors, complying with Section 088000 “Glazing.” Install glass using manufacturer’s standard elastomeric glazing sealant complying with ASTM C920. Secure glass in place with removable wood moldings. Miter wood moldings at corner joints.
E. Transom and Side Panels:
   1. Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors.
   2. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
   3. Fabricate door and transom panels with full-width, solid-lumber meeting rails.
4. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.

F. Exterior Doors: Factory treat exterior doors with water-repellent preservative after fabrication has been completed but before factory finishing.
   2. Flash top of outswinging doors with manufacturer's standard metal flashing.

2.3 FACTORY FINISHING

A. Comply with referenced quality standard for factory finishing.
   1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
   2. Finish faces, all four edges, edges of cutouts, and mortises.

B. Transparent Finish: WDMA I.S. 6A Premium Grade.
   2. Staining, effect and Sheen: Match Architect's approved sample.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames, with Installer present, before hanging doors.
   1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
   2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware Installation: Section 087100 - Door Hardware.

B. Install doors and frames to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

C. Align and fit doors in frames with uniform clearances and bevels as indicated below.
   1. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.

D. Machine doors for hardware.

E. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

F. Clearances:
   1. Provide 1/8 inch at heads, jambs, and between pairs of doors.
   2. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
   3. Where threshold is shown on Drawings or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.

G. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.

H. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
I. Factory- Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION
SECTION 08 31 00
ACCESS DOORS & PANELS

PART 1 GENERAL

1.1 SUMMARY
   A. Section Includes: Access panels (AP).

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of door and frame indicated. Include construction details relative to materials, individual components and profiles, finishes, and fire ratings (if required) for access doors and frames.
   B. Schedule: Provide complete access panel schedule, including types, general locations, sizes, construction details, latching or locking provisions, and other data pertinent to installation.

1.3 COORDINATION
   A. Access Panel Schedule: Determine specific locations and sizes for access doors needed to gain access to concealed equipment, and indicate on schedule specified in "Submittals" Article.
   B. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed equipment, and indicate on schedule specified in "Submittals" Article.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection and temperature-rise limit ratings indicated, according to NFPA 252 or UL 10B.

2.2 PRODUCTS AND MANUFACTURERS
   A. Products and Manufacturers: Subject to compliance with specified requirements, provide Basis of Design or approved equivalent by one of the following manufacturers:
      1. J.L. Industries
      2. Karp Associates Inc.
      3. Milcor Inc.
      4. Potter Roemer

2.3 ACCESS PANELS
   A. General:
      1. Sizes: As shown on Drawings.
      2. Latch and Lock Hardware:
         a. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
         b. Keys: Furnish two keys per lock and key all locks alike.
      3. Accessories: Provide accessories as required for complete and operable installation.
         a. Expansion shields
         b. Steel frame
         c. Continuous steel hinge
d. Automatic closing and locking device  
e. Flush key operated cylinder lock  
f. Anchorage  

B. (AP-1) Non-Rated Steel Access Door with Exposed Flanges: General purpose flush access door with exposed flanges; face of door flush with frame, with 1-inch exposed flange and concealed, removable, button hinge.  
1. Steel Sheet:  
a. Door Material: Nominal 0.062 inch (16 gauge). Fold on all four sides for structural rigidity.  
b. Frame Material: Nominal 0.062 inch, (16 gauge). Provide 1/4-inch mounting holes and easy install tabs.  
c. Finish: Paintable powder-coat, white.  

C. (AP-2) Fire-rated, flush metal access panel complying with UL, and self-closing door.  
1. Milcor: Style URF flush panel for gypsum board (and veneer plaster),  
2. Milcor: Style CFRAD flush panel for gypsum board (and veneer plaster),  
3. Provide fire-rated access doors, B label at fire rated walls or ceilings.  

1. Basis of Design: Bauco Plus II.  

E. (AP-4) Non-Rated Stainless Steel Access Door with Exposed Flanges: General purpose flush access door with exposed flanges; face of door flush with frame, with 1-inch exposed flange and concealed, removable, button hinge.  
1. Stainless-Steel Sheet, Type 304:  
a. Door Material: Nominal 0.063 inch (16 gauge).  
b. Frame Material: Nominal 0.063 inch (16 gauge).  
c. Finish: No. 4 finish.  

F. Non-Rated Steel Access Door with Concealed Flanges and Gypsum Board Insert: General purpose flush access door with a flange that will accept drywall compound for a concealed frame appearance; door face recessed to accept gypsum board insert; concealed mudded-in flange and concealed hinge.  
1. Steel Sheet:  
a. Door Material: Nominal 0.062 inch (16 gauge). Fold on all four sides for structural rigidity.  
b. Frame Material: Nominal 0.062 inch, (16 gauge). Provide 1/4-inch mounting holes and easy install tabs.  
c. Finish: Paintable powder-coat, white.  

G. Hinges: Concealed spring, button type, to allow for door removal.  

2.4 MATERIALS  
A. Materials:  
1. Aluminum Sheet for Door: Nominal 0.045 inch, with mill finish.  

B. Steel Plates, Shapes, and Bars: ASTM A 36.  

C. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879, with cold-rolled steel sheet substrate complying with ASTM A 1008, Commercial Steel (CS), exposed.  

D. Metallic-Coated Steel Sheet: ASTM A 653, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.  

E. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, [Type 304] [Type 316]. Remove tool and die marks and stretch lines, or blend into finish.
F. Aluminum Extrusions: ASTM B 221, Alloy 6063.
G. Aluminum Sheet: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
H. Frame Anchors: Same material as door face.
I. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.5 FABRICATION
A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
   1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
   2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.

2.6 FINISHES
A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
D. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Deliver inserts and rough-in frames to job site at appropriate time for building-in. Provide templates and rough-in measurements as required.
B. Before starting work notify Architect in writing of conflicts detrimental to installation or operation of units.
C. Verify with Architect location of access panels.

D. Advise installers of other work about specific requirements relating to access door and floor door installation, including sizes of openings to receive access door and frame, as well as locations of supports, inserts, and anchoring devices.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for installing access panels and frames, and floor doors and frames.

B. Install plumb, square and level, securely fastened, properly anchored and ready for full, complete operation and use.

C. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.

D. Install access doors with trimless frames and floor doors flush with adjacent finish surfaces or recessed to receive finish material.

E. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION
SECTION 083300
ACOUSTICAL FIRE & SMOKE RATED DOORS

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

A. Provide all materials, labor, equipment and services necessary to furnish, deliver and install all work under this section as shown on the contract documents, specified herein, and as specified by the job conditions.

1.02 DESCRIPTION

A. Related work specified elsewhere:
   1. Metal Fabrication.   Section 05 50 00
   2. Rough Carpentry.   Section 06 10 00
   3. Painting:   Section 09 91 00
   4. Electrical:   Division 26

1.03 SUBMITTALS

A. Procedures: Furnish submittals in accordance with the general requirements specified.

B. Shop Drawing: Furnish shop drawings for architect's approval. Include elevations, sections, and details indicating dimensions, materials, finishes, conditions for anchorage and support of each door.

C. Certifications:
   1. Submit manufacturer’s Underwriters Laboratories (UL), Warnock Hersey (WH) or Factory Mutual Research (FM) laboratory test report verifying product compliance in accordance with the required fire and smoke ratings.
   2. Provide certification from an accredited acoustical testing laboratory of product compliance noting a minimum 34 STC rating. Assembly shall have been tested in accordance with Laboratory Sound Transmission Loss (ASTM E-90) and STC determination (ASTM E-413).
   3. Submit manufacturer’s Code Compliance Research Report published by an independent third-party testing agency that is certified by the International Accreditation Service confirming compliance of the fire door assembly in accordance with the International Building Code.

D. Product Literature: Submit manufacturer’s technical literature describing the product to be used under this section.

E. Maintenance and Operating Manuals: Furnish complete manuals describing the materials, devices and procedures to be followed in operating and maintaining all doors under this section. Include manufacturer’s brochures and parts lists describing the actual materials used in the product.

1.04 QUALITY ASSURANCE

A. Fire & Smoke Rated Assemblies: Provide all doors with fire and smoke resistance rating required to comply with governing regulations which are inspected, tested, listed and labeled by UL, WH or FM and complying with NFPA 80 for class of opening. Provide units tested in accordance with the requirements of UL 10B, UL 1784, NFPA 252, ASTM E-152. Provide testing laboratory label permanently fastened to each fire and smoke door assembly.

B. Regulatory Requirements:
   1. Comply with applicable requirements of the laws, codes, ordinances and regulations of federal,
state and municipal authorities having jurisdiction.
2. Listed under a certified Code Compliance Research Report in accordance with the applicable sections of the International Building Code.

C. Testing: Provide documentation from a certified testing agency that the fire door's self-closing governor mechanism and fire door operator have been tested for a minimum of 50,000 cycles and 500 self closing trip tests.

D. Manufacturer Requirements: Door manufacturer shall have been in the business of and have experience in manufacturing the type of product covered under this specification section as well as giving credible service for a minimum of five (5) years. Provide list of at least ten (10) completed projects which include the products covered under this section.

1.05 DELIVERY, STORAGE AND HANDLING

A. General: Deliver and store materials in manufacturer's original packaging, labeled to show name, brand and type. Store materials in a protected dry location off the ground in accordance with manufacturer's instructions.

1.06 WARRANTY

A. Door Warranty: Provide Two (2) Year Warranty signed by the manufacturer and installer agreeing to repair or replace work which has failed as a result of defects in materials or workmanship. Upon notification within the warranty period, such defects shall be repaired at no cost to the owner.

PART 2 PRODUCTS

2.01 ACOUSTICAL FIRE & SMOKE RATED DOORS

A. CD-3: Manufacturer: Rolling Fire Door shall be model ERD10 by Cookson Door.
   a. Provide doors with Underwriters' Laboratories, Inc. label for the fire rating classification - 45 MIN Rating
   b. Color: PT-1
B. CD-4: Manufacturer: Vertical Acting Fire Door system - Acoustical fire and smoke rated door shall be Auto-Set® System model FSFD-STC-M-G as manufactured by McKEON.
   a. Provide doors with Underwriters' Laboratories, Inc. label for the fire rating classification - 90 MIN Rating

2.02 MATERIALS

A. Curtain: Shall be assembled of G90 galvanized steel interlocking slats. Slats shall have endlocks locking each end of all alternate slats to act as a wearing surface and maintain slat alignment. Curtain shall be formed of 20 gauge front and back panel slats. Slats shall be filled with acoustical core with the front and back panel slats having a positive interlock, snap-in back panel slats are not acceptable.
   1. Slats: Shall be of a cross section not less than 3" wide by 1 7/16" deep.
B. Bottom Bar: Shall consist of two (2) angles, each not less than 2" x 2" x 1/8" steel formed to fit slats. Bottom bar shall be provided with continuous form fitted acoustical seals.
C. Guides: Each guide assembly shall be fabricated of a minimum 3" x 3" steel support angle or tube, a 3" x 4" inner guide angle and a 4" x 4" outer guide angle. Support tubes shall be constructed with a slip joint at the top to provide for thermal expansion and guide angles shall be provided with slotted holes to allow for thermal expansion.
   1. Acoustical Seals: Provide internal, fully concealed UL Classified acoustical smoke seals,
located within each guide assembly, as required to maintain the minimum 34 STC rating. Externally mounted smoke seals shall not be acceptable.

D. Mounting Brackets: Fabricated of hot rolled 3/16” steel plate minimum, brackets shall be provided to house ends of the counterbalance barrel assembly.

E. Hood: Shall be provided to entirely enclose curtain and counterbalance barrel assembly. Hood shall be fabricated 22 gauge G90 galvanized steel and designed to match brackets. Top and bottom shall be bent and reinforced for stiffness.
   1. Sound Baffle: Provide self adjusting internal sound baffle with integral lintel acoustical smoke seals as required to maintain the minimum 34 STC rating.

F. Counterbalance Assembly: Fire door shall be counterbalanced by means of adjustable steel helical torsion springs attached to shaft enclosed in pipe with required mounting blocks or rings for attachment of curtain. Grease sealed bearings or self-lubricating graphite bearings shall be attached to the spring barrel which shall be fabricated of hot formed structural quality carbon steel seamless pipe.

G. Electric Motor Operator: Fire door shall be provided with a compact power unit designed and built by the door manufacturer. Operator shall be equipped with an adjustable screw-type limit switch to break the circuit at termination of travel. High efficiency planetary gearing running in an oil bath, shall be furnished together with a centrifugal governor, magnetic operated brake and a fail-safe magnetic release device, completely housed to protect against damage, dust and moisture. An efficient overload protection device, which will break the power circuit and protect against damage to the motor windings shall be integral with the unit. Operator is to be housed in a NEMA type 1 enclosure.
   1. Motor: Shall be intermediate duty, thermally protected, ball bearing type with a class A or better insulation. Horsepower of motor is to be 1/3hp minimum or of manufacturer's recommended size, which ever is greater.
   2. Starter: Shall be size "0" magnetic reversing starter, across the line type with mechanical and electrical interlocks, with 10 amp continuous rating and 24 volt control circuit. Reducer: Planetary gear type, 80% efficiency minimum.
   3. Brake: Magnetically activated, integral within the operator's housing.
   4. Control Station: Provide flush mount key switch control station marked open, close and stop.

H. Self-Closing Mechanism: The fire door is to be designed with a centrifugal governor as an integral part of the operator's construction. The automatic release mechanism shall be activated by a fusible link, smoke detector or fire alarm. When activated the door is released and begins to close due to gravitational force. The speed of the door is governed by a centrifugal governor, designed to match the normal operating speed of the door, at a rate of not greater than 9” per second or less than 6” per second.

I. Magnetic Release with 10 Second Time Delay: A fail-safe magnetic release device shall be built into the operator as an integral part of the release mechanism. When power is interrupted to the release mechanism by the smoke detector or fire alarm, the door shall begin to self-close. In the event of power failure the time delay shall prevent the fire door from closing for a period of 10 seconds. Once the 10 seconds have lapsed, the fire door shall self-close. Once power has been restored to the release mechanism the automatic reset time delay as well as the fire door shall automatically reset themselves.

J. Obstruction Sensing Safety Edge: The fire door shall be designed with an obstruction sensing safety edge. In the event that the safety edge meets an obstruction during the normal closing operation, the door shall stop, reverse and return to the open position. In the event the safety edge meets an obstruction during the self-closing operation, the door shall come to rest on the
obstruction and once the obstruction has been removed the fire door shall continue to the fully closed position.

K. Easy Trip Test Feature: The fire door shall be designed so that it may be trip tested simply by cutting power to the operator. By turning the power switch off, the door shall self-close. Once the fire door has satisfactorily closed, it shall be reset simply by turning the power back on. No ladders or tools shall be needed to reset the door or the time delay unit.

L. True Test Panel: Fire doors shall be provided with a True Test panel. The test panel shall activate all the fire doors to close via gravity not power and shall be in accordance with NFPA Bulletin 80. Only one test panel shall be required to test all the fire doors on this project.

M. Finish: After completion of fabrication, clean all metal surfaces to remove dirt and chemically treat to provide for paint adhesion. Curtain assembly is to receive a prime coat finish of .2 mils of epoxy primer and .8 mils of polyester paint in a McKEON Black finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine surfaces and field conditions to which this work is to be performed and notify architect if conditions of surfaces exist which are detrimental to proper installation and timely completion of work.

B. Verify all dimensions taken at job site affecting the work. Notify the architect in any instance where dimensions vary.

C. Coordinate and schedule work under this section with work of other sections so as not to delay job progress.

3.02 INSTALLATION

A. Perform installation using only factory approved and certified representatives of the door manufacturer.

B. Install door assemblies at locations shown in perfect alignment and elevation, plumb, level, straight and true.

C. Adjust door installation to provide uniform clearances and smooth non-binding operation.

D. Install wiring in accordance with applicable local codes and the National Electrical Code Standard. Materials shall be UL listed.

E. Test door closing sequence when activated by the building's fire alarm system. Reset door after successful test.

3.03 PROTECTION AND CLEANING

A. Protect installed work using adequate and suitable means during and after installation until accepted by owner.

B. Remove, repair or replace materials which have been damaged in any way.

C. Clean surfaces of grime and dirt using acceptable and recommended means and methods.
END OF SECTION
SECTION 083323
OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Motor-operated, insulated overhead coiling doors (CD-1) and (CD-2).

1.2 ACTION SUBMITTALS
A. Product Data: For each type and size of overhead coiling door and accessory. Include the following:
   1. Construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
   2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer’s product data. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Show locations of controls, locking devices and other accessories.
   3. Wiring Diagrams: For power, signal, and control wiring.
C. Samples: For each type of exposed finish required, prepared on 12-inch long curtain slats.

1.3 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified Installer.
B. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: Manufacturer’s authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

PART 2 PRODUCTS

2.1 COILING DOORS
A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.
   1. Obtain operators and controls from overhead coiling door manufacturer.
B. Manufacturers: Subject to compliance with requirements, provide Basis of Design or equivalent products by one of the following:
   1. Cookson Company.
   2. Cornell Iron Works, Inc.
   3. McKeon Rolling Steel Door Company, Inc.
   4. Overhead Door Corporation.
C. (CD-1) and (CD-2) Insulated, Motor-Operated, Overhead Coiling Door:
2. Steel Door Curtain: Galvanized steel, flat profile slats.
   a. Insulated-Slat Interior Facing: Metal.
   b. Curtain R-Value: 6.0 deg F x h x sq. ft./Btu.
3. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84 or UL 723. Enclose insulation completely within slat faces.
4. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.
5. Hood: Match curtain material and finish.
   a. Shape: Square.
   b. Mounting: Face of wall.
   c. Locking Devices: Equip door with locking device assembly; inside and outside with cylinders.
6. Finishes: Manufacturer's powder-coated finish, color as selected by Architect from manufacturer's full range.
   b. Bonderized coating for prime coat adhesion.
   c. Corrosion inhibiting primer .2 mils per side.
   d. Thermo-setting polyester top coat with a minimum thickness of .6 mils each side.
   e. Color: Custom color as selected by Architect to match PT-__.

D. Electric Door Operator: Model MG (Industrial Duty Gear Head) Operator by Cookson.
1. Operator Location: Top of hood.
5. Sensor Edge Bulb Color: As selected by Architect from manufacturer's full range.

E. Control Station: As selected by Architect.
1. Surface mounted: "Open/Close/Stop" push buttons; NEMA 1
2. Surface mounted: "Open/Close" key switch with "Stop" push button; NEMA 3R
3. Surface mounted: "Open/Close/Stop," push buttons with keyed lock-out, not masterkeyable; NEMA 4

F. Control Operation: As selected by Architect.
1. Constant Pressure to Close:
   a. No sensing device required
   b. Two-wire, electric sensing edge seal extending full width of door bottom bar. Contact before door fully closes shall cause door to immediately stop downward travel and reverse direction to the fully opened position. Provide a [retracting safety cord and reel] [self-coiling cable] connection to control circuit.
   a. Two-wire, E.L.R. electric sensing/weather edge seal extending full width of door bottom bar. Provide a [retracting safety cord and reel] [self-coiling cable] connection to control circuit.
   b. NEMA 4X photo eye sensors consisting of a transmitter and receiver that are to be mounted within 6" (152.4 mm) of the floor, projecting an IR beam across the entire width of the door. Electrical contractor to provide low voltage wiring from the transmitter and receiver to the door operator.
c. NEMA 1 photo eye sensors consisting of a transmitter and receiver that are to be mounted within 6” (152.4 mm) of the floor, projecting an IR beam across the entire width of the door. Electrical contractor to provide low voltage wiring from the transmitter and receiver to the door operator.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces and field conditions to which this work is to be performed and notify architect if conditions of surfaces exist which are detrimental to proper installation and timely completion of work.

B. Verify all dimensions taken at job site affecting the work. Notify the architect in any instance where dimensions vary.

C. Coordinate and schedule work under this section with work of other sections so as not to delay job progress.

3.2 INSTALLATION

A. Perform installation using only factory approved and certified representatives of the door manufacturer.

B. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

C. Install overhead coiling doors, hoods, and operators at the mounting locations indicated for each door.

D. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

E. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.

F. Adjust door installation to provide uniform clearances and smooth non-binding operation.

G. Install wiring in accordance with applicable local codes and the National Electrical Code Standard. Materials shall be UL listed.

H. Test door closing sequence when activated by the building's fire alarm system. Reset door after successful test.

3.3 INSTALLED WORK

A. Remove, repair or replace materials which have been damaged in any way.

B. Start-Up Service: Engage a factory-authorized service representative to perform startup service.
   1. Perform installation and startup checks according to manufacturer's written instructions.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Adjusting: Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
   1. Lubricate bearings and sliding parts as recommended by manufacturer.

D. Demonstration: Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.
E. Cleaning: Clean surfaces of grime and dirt using acceptable and recommended means and methods.

F. Protection: Protect installed work using adequate and suitable means during and after installation until accepted by owner.

END OF SECTION
SECTION 083473
SOUND CONTROL DOOR ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes: Metal sound control doors, door frames, glass and glazing, perimeter sealing devices, door hinges and accessories (SCDA).

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product. Include sound ratings, construction details, material descriptions, core descriptions and finishes.
B. Shop Drawings: For fabrication and installation of door panels, door frames, hardware, and acoustical seals, including:
   1. Elevations of each door design.
   2. Details of sound control seals, door bottoms, and thresholds.
   3. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
   4. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   5. Locations of reinforcements and preparations for hardware.
   7. Anchorages, joints, field splices, and connections.
   8. Accessories, moldings, removable stops, and glazing.

1.3 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of sound control door assembly.
B. Product Test Reports: For each sound control door assembly, for tests performed by a qualified testing agency.
   1. Submit certified copies of 1/3 Octave Band Transmission Loss test data and STC rating as issued by an accredited independent acoustical laboratory.
C. Schedule: Provide a schedule of sound control door assemblies prepared using same reference numbers for details and openings as those on Drawings. Coordinate with the Door Hardware Schedule.

1.4 QUALITY ASSURANCE
A. Laboratory Certification: Acoustical testing of submitted doors assemblies shall be conducted in an accredited independent acoustical laboratory. Sound transmission loss values shall be determined in accordance with ASTM E90-90. Sound Transmission Class (STC) shall be determined in accordance with ASTM E413-87.
B. Certification of acoustical tests must be submitted by Contractor for approval prior to installation.
C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
D. Acoustical Testing Agency Qualifications: An independent agency accredited as an acoustical laboratory according to the National Voluntary Laboratory Accreditation Program of NIST.
E. Fabrication shall not proceed until written approval of Submittal has been issued.
F. Door Weight: The force in pounds required to open and operate each door panel shall be in accordance with the requirements of the Americans with Disabilities Act.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and project-site storage. Avoid the use of nonvented plastic.
   1. Provide additional protection to prevent damage to factory-finished units.
B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

1.6 COORDINATION
A. Coordinate installation of anchorages for sound control door assemblies. Furnish setting drawings, templates, and directions for installing anchorages. Deliver sleeves, inserts, anchor bolts, and items with integral anchors to project site in time for installation.

1.7 WARRANTY
A. Special Warranty: Manufacturer agrees to repair or replace components of sound control door assemblies that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure to meet sound rating requirements.
      b. Faulty operation of sound seals.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use or weathering.
   2. Warranty Period: Five years from date of Substantial Completion.

1.8 FIELD QUALITY CONTROL
A. Refer to Field Quality Control article in Part 3.
B. Contractor shall guarantee acoustical performance in the field of the Sound Retardant Steel Doors. The acoustical performance rating in the field shall not be less than a Noise Isolation Class (NIC) 5 dB lower than the laboratory STC rating of the door assembly when tested in the field in accordance with the noise reduction test procedure ASTM 336-75.
C. The field test will be conducted by the Architect's acoustical consultant. The manufacturer's representatives should be present to observe testing procedures and conditions. Approval of test data to be given by Architect or representative of Architect.
D. The requirement that the Contractor, at the time of bidding, submit certification of STC rating as obtained in an accredited acoustical laboratory, is mandatory. The guarantee of the achievement of acoustical performance of the NIC rating in the field will not be accepted as a substitute for the laboratory test certification. Complete compliance with the acoustical performance specifications, both laboratory and field, is required of the Contractor to be eligible as a bidder on the furnishing and installation of the Sound Retardant Steel Doors.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Acoustic Performance: Provide pre-hung sound control door and frame assemblies with sound rating specified, as calculated by ASTM E 413 when tested in an operable condition according to ASTM E 90; and identical to those of assemblies tested as sound-retardant units by an acoustical testing agency.

1. (SCDA-1) Sound Rating: STC 51; with and a minimum 28 dB at the 125 Hz 1/3-octave band.

B. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.2 PRODUCTS AND MANUFACTURERS

A. Source Limitations: Obtain steel sound control door assemblies, including doors, frames, sound control seals, hinges, thresholds, and other items essential for sound control, from single source from single manufacturer.

B. (SCDA-1) Sound Control Door Assemblies: Acoustically-tested and rated assembly, consisting of steel frames with pre-hung, factory-adjusted steel doors, factory-installed hardware, including cam-lift hinges, continuous sound gasketing, threshold and other door hardware as scheduled. Provide factory-installed glazing as scheduled. Provide fire-rated assembly as scheduled.

C. Basis of Design: Subject to compliance with specified requirements, provide one of the following:

1. QuietSwing Series - Architectural Sound Control Doors by Noise Barriers, LLC.

2.3 FRAMES

A. Frames: Fabricate sound control door frames with corners mitered, reinforced, and continuously welded the full depth and width of frame. Fabricate according to NAAMM-HMMA 865.

1. Weld frames according to NAAMM-HMMA 820.
2. Exterior Frames: Fabricate from metallic-coated steel sheet 0.079-inch nominal thickness or thicker as required to provide STC rating indicated.
3. Interior Frames: Fabricate from cold-rolled steel sheet unless otherwise indicated, 0.075-inch nominal thickness or thicker as required to provide STC rating indicated.
4. Hardware Reinforcement: Fabricate according to NAAMM-HMMA 865 of same material as face sheets.
5. Head Reinforcement: Metallic-coated steel channel or angle stiffener, 0.108-inch nominal thickness. Provide for grouted frames installed in masonry openings greater than 48 inches
6. Jamb and Floor Anchors: As recommended by door assembly manufacturer.
8. Plaster Guards: Metallic-coated steel sheet, not less than 0.026 inch thick. Provide at grouted frames.
B. Frame Fabrication: Fabricate sound control frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
   1. Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated from same thickness metal as frames.
   2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   3. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
   4. Jamb Anchors: Provide number and spacing of anchors as recommended by dorr assembly manufacturer.
   5. Head Reinforcement: For grouted frames more than 48 inches wide, weld continuous head reinforcement to back of frame at head full width of opening.
   6. Hardware Preparation: Factory prepare sound control frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping.
      a. Reinforce frames to receive nontemplated mortised and surface-mounted door hardware.
      b. Locate hardware as indicated, or if not indicated, according to NAAMM-HMMA 831, “Recommended Hardware Locations for Custom Hollow Metal Doors and Frames.”
   7. Plaster Guards: Weld guards to frame at back of hardware cutouts and glazing-stop screw and sound control seal preparations to close off interior of openings in frames to be grouted.
   8. Tolerances: Fabricate frames to tolerances indicated in NAAMM-HMMA 865.

C. Shop Primer Finish: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.4 STEEL DOORS

A. Doors: Flush-design sound control doors, [thickness as required to provide STC rating, of seamless construction; with manufacturer's standard sound-retardant core as required to provide STC and fire rating indicated. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges. Fabricate according to NAAMM-HMMA 865.
   1. Interior Doors: Fabricate from cold-rolled steel sheet unless otherwise indicated, 0.048-inch nominal thickness or thicker as required to achieve STC rating indicated.
   2. Core: Manufacturer's standard sound control core.
   3. Loose Stops for Glazed Lites in Doors: Same material as face sheets.
   4. Top and Bottom Channels: Closed with continuous channels of same material as face sheets, spot welded to face sheets not more than 6 inches o.c.
   5. Hardware Reinforcement: Same material as face sheets.

B. Materials:
   1. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS), Type B, suitable for exposed applications.
   2. Glazing: As required by sound control door assembly manufacturer to comply with sound control and fire-rated-door labeling requirements.

C. Door Fabrication: Sound control doors to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.
   1. Comply with requirements in NFPA 80 for fire-rated and smoke control doors.
   2. Seamless Edge Construction: Fabricate doors with faces joined at vertical edges by welding; welds shall be ground, filled, and dressed to make them invisible and to provide a smooth, flush surface.
3. Glazed Lites: Factory install glazed lites according to requirements of tested assembly to achieve STC rating indicated. Provide fixed stops and moldings welded on secure side of door.

4. Hardware Preparation: Factory prepare sound control doors to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping.
   a. Reinforce doors to receive nontemplated mortised and surface-mounted door hardware.
   b. Locate door hardware as indicated, or if not indicated, according to NAAMM-HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."

5. Tolerances: Fabricate doors to tolerances indicated in NAAMM-HMMA 865.

D. Shop Primer Finish: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.5 HARDWARE

A. Sound Control Door Hardware: Manufacturer's standard sound control system, including head and jamb seals, door bottoms, cam-lift hinges, and thresholds, as required by testing to achieve STC and fire rating indicated.

1. Head and Jamb Seals: One of the following:
   a. Neoprene Compression Seals: One-piece units consisting of closed-cell sponge neoprene seal held in place by metal retainer, with retainer cover of same material as door frame; attached to door frame with concealed screws.
   b. Silicone Compression Seals: One-piece units consisting of silicone compression bulb and stabilizer flange; attached to door frame adhesively.
   c. Magnetic Seals: One-piece units consisting of closed-cell sponge neoprene seal and resiliently mounted magnet held in place by metal retainer, with retainer cover of same material as door frame; attached to door frame with concealed screws.

2. Door Bottoms: Neoprene or silicone gasket held in place by metal housing; mortised into bottom edge of door.

3. Cam-Lift Hinges: Full-mortise template type that raises door 1/2 inch when door is fully open; with hardened pin; fabricated from stainless steel.

4. Thresholds: Flat, smooth, unfluted type as recommended by manufacturer; fabricated from [clear-anodized aluminum] [stainless steel].
   a. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities].

2.6 INSTALLATION ACCESSORIES

A. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.

B. Grout: Comply with ASTM C 476, with a slump of not more than 4 inches as measured according to ASTM C 143.

C. Corrosion-Resistant Coating For Grouted Frames: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
B. Examine roughing-in for embedded and built-in anchors to verify actual locations of sound control door frame connections before frame installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prior to installation, adjust and securely brace sound control door frames to the following tolerances:
   1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
   3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

B. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install sound control door assemblies plumb, rigid, properly aligned, and securely fastened in place; comply with manufacturer's written instructions.

B. Frame Installation: Install sound control door frames in sizes and profiles indicated.
   1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
      a. At fire-rated openings, install frames according to NFPA 80.
   2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
   4. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   5. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   6. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.
   7. Grouted Frames: Solidly fill space between frames and substrate with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
   8. Installation Tolerances: Adjust sound control door frames for squareness, alignment, twist, and plumbness to the following tolerances:
      a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
      b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
      c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Doors: Fit sound control doors accurately in frames, within clearances indicated below. Shim as necessary.
   1. Non-Fire-Rated Doors: Fit non-fire-rated doors accurately in frames with the following clearances:
      b. Head with Butt Hinges: 1/8 inch.
      c. Head with Cam-Lift Hinges: As required by manufacturer, but not more than 3/8 inch.
      d. Sill: Manufacturer’s standard.
      e. Between Edges of Pairs of Doors: 1/8 inch.
   2. Fire-Rated Doors: Install fire-rated doors with clearances according to NFPA 80.

D. Sound Control Seals: Where seals have been factory prefitted and preinstalled and subsequently removed for shipping, reinstall seals and adjust according to manufacturer’s written instructions.

E. Cam-Lift Hinges: Install hinges according to manufacturer’s written instructions.

F. Thresholds: Set thresholds in full bed of sealant complying with requirements in Section 079200 - Joint Sealants.

G. Glazing: Comply with installation requirements in Section 088000 - Glazing and with sound control door assembly manufacturer’s written instructions.
   1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 FIELD QUALITY CONTROL

A. Testing Agency for Field Testing: Engage Architect’s Acoustics Consultant to perform tests and inspections.
   1. Acoustical testing and inspecting agency shall select one sound control door(s) at random from sound control door assemblies that are completely installed for testing.
   2. Field tests shall be conducted according to ASTM E 336, with results calculated according to ASTM E 413. Acceptable field NIC values shall be within 5 dB of laboratory STC values.
   3. Inspection Report: Acoustical testing agency shall submit report in writing to Architect and Contractor within 24 hours after testing.
   4. If tested door fails, replace or rework all sound control door assemblies to bring them into compliance at Contractor’s expense.
      a. Additional testing and inspecting at Contractor’s expense will be performed to determine if replaced or additional work complies with specified requirements.

B. Prepare test and inspection reports.

3.5 ADJUSTING AND CLEANING

A. Final Adjustments: Check and adjust seals, door bottoms, and other sound control hardware items right before final inspection. Leave work in complete and proper operating condition.

B. Remove and replace defective work, including defective or damaged sound seals and doors and frames that are warped, bowed, or otherwise unacceptable.
   1. Adjust gaskets, gasket retainers, and retainer covers to provide contact required to achieve STC rating.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible, rust-inhibitive, air-drying primer.
D. Metallic-Coated Surfaces: Clean abraded areas of doors and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION
SECTION 084400
ALUMINUM CURTAIN WALLS, STOREFRONTS & ENTRANCES

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Glazed aluminum-framed curtain walls, storefronts and entrances (AFS).
   2. Anchors, brackets, reinforcements and attachments.
   3. Design and fabrication of system with required reinforcement to meet design intent of systems specified and performance required.
   4. Field testing of glazed aluminum curtain walls.
   5. Engineering required to comply with specified performance requirements.

1.2 COORDINATION
A. Pre-installation Conference: Before beginning curtain wall installation, conduct pre-installation conference at Project site with curtain wall system manufacturer, installer, Architect, Owner and other interested parties to review procedures, schedules, and coordination of curtain wall installation with other elements of Work.
B. Field Measurements: Verify actual supporting and adjoining construction by field measurements before fabrication; and indicate recorded measurements on final Shop Drawings.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
   1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
   2. Include full-size isometric details of each type of vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
      a. Joinery, including concealed welds.
      b. Anchorage.
      c. Expansion provisions.
      d. Glazing.
      e. Flashing and drainage.
   3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
C. Samples: Submit samples illustrating prefinished aluminum surface, specified glass and insulated infill panels, including glazing edge and corner, and glazing materials.
D. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:
   1. Joinery, including concealed welds.
   2. Anchorage.
   5. Flashing and drainage.
E. Manufacturer's Thermal Analysis: Submit report of thermal analysis performed by Manufacturer for this Project, evaluating the surface temperatures and dew point of installed and glazed curtain wall system, under typical conditions temperature, relative humidity and wind speed. Performance requirement of no condensation under the following conditions:
   1. Exterior Dry Bulb Temperature: 10 degrees F.
   2. Interior Dry Bulb Temperature: 74 degrees F.
   3. Relative Humidity: 35 percent.

F. Delegated Design Submittal and Shop Drawings: Where professional design services or certifications by a qualified Professional Engineer are specifically required of the Contractor by the Contract Documents, in accordance with the delegated design submittal requirements in Section 013300 - Submittal Procedures.

G. Calculations: Upon request from the Architect/Engineer only, submit calculations in accordance with Section 013300 – Submittal Procedures.

H. Certifications:
   1. Manufacturer certificate signed by manufacturer certifying compliance with requirements of Quality Assurance article.
   2. Installer certificates signed by manufacturer certifying that installer complies with requirements of Quality Assurance article.
   3. Professional Engineer certificate signed by manufacturer certifying that Professional Engineer complies with requirements of Quality Assurance article.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.2, “Structural Welding Code – Aluminum”.

B. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of curtain wall assemblies.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.5 MOCKUPS

A. Mockup Pre-Installation Conference: Before beginning curtain wall mock-up construction and installation, conduct pre-installation conference at Project site with curtain wall system manufacturer, installer, Architect, Owner and other interested parties to review procedures, schedules, and coordination of curtain wall installation with other elements of Work.
   1. Provide system fabrication sample for pre-installation meeting.

B. Provide mockups of curtain wall system in accordance with Contract Documents to be field-tested for air and water infiltration.
   1. Architect will observe complete installation of curtain wall mock-up.
   2. Mock-up shall including intermediate mullion, sill muntin, and vision glass light.
   3. Coordinate with Work of other sections to include adjacent assemblies required to be included in mock-up and in accordance with Section 014339.
4. Mock-ups to demonstrate aesthetic effects and set quality standards for fabrication and installation.
5. Mock-ups to demonstrate component assembly including integral glazing materials, weep drainage system, attachments, and anchors.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Engineering Responsibility: Engage a qualified Professional Engineer to provide delegated design services in accordance with Section 013300 – Submittal Procedures

B. General Performance: Comply with performance requirements specified, as determined by testing of glazing systems representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Maintain continuous air and vapor barrier throughout assembly primarily in line with (inside) pane of glass and heal bead of glazing sealant.
   2. Glazed aluminum framing systems shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   3. Failure also includes the following:
      a. Thermal stresses transferring to building structure.
      b. Glass breakage.
      c. Noise or vibration created by wind and thermal and structural movements.
      d. Loosening or weakening of fasteners, attachments, and other components.
      e. Failure of operating units.

4. Thermal Movement: System to provide for expansion and contraction within system components caused by cycling temperature change without causing detrimental effects to system or components.
   a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Structural Loads: Design and construct curtainwall system, including anchorages, to withstand dead loads of curtainwall system and wind loads caused by pressure and suction of wind acting normal to plane of wall as calculated in accordance with requirements of authorities having jurisdiction or ANSI/ASCE 7-10, whichever are more stringent.
   1. Wind Load Provisions of ANSI/ASCE 7-10 as shown on Structural Drawings.
   2. Deflection of Framing Members: At design wind pressure, as follows:
      a. Deflection Normal to Wall Plane: When subjected to design wind loads or concentrated maintenance loads shall be limited to following:
         1) Spans up to 13 feet-6 inches: limit deflection to L/175.
         2) Spans greater than 13 feet-6 inches: limit deflection to L/240 plus 1/4 inch.
         3) Cantilevered members: limit deflection to lesser of 2L/175 or 3/4 inch.
         4) No permanent deformation in excess of 0.2 percent of its span.
         5) The deflection of any member (such as vertical jambs) shall not impair the function of system or damage any joint seals as warranted by the manufacturer.
      b. Deflection Parallel to Glazing Plane: Shall not exceed an amount which will reduce the glass bite below 75 percent of design dimension, and member shall have a minimum 1/8 inch clearance between itself and edge of fixed panel, glass or fixed part immediately below.
         1) Structural Support Movement: System to accommodate anticipated interstory differential live load vertical movement of 5/16 inch (downward) in addition to anticipated thermal movement.
2) Sidesway Movement: System to accommodate anticipated interstory differential drift of H/400 in any horizontal direction.

2.2 THERMAL AND INFILTRATION PERFORMANCE REQUIREMENTS

A. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
   1. No evidence of water penetration through fixed glazing and framing areas [including entrance doors] when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft..
   2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies’ normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

B. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:
   1. Thermal Transmittance: Maximum U-factor when tested in accordance with NFRC 100.
      a. Fixed Glazing and Framing: Not more than 0.29 Btu/sq. ft. x h x deg F.
      b. Entrance Doors: Not more than 0.77 Btu/sq. ft. x h x deg F.
   2. Air Leakage: Maximum when tested in accordance with ASTM E283.
      a. Fixed Glazing and Framing: Not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft..
      b. Entrance Doors: Not more than 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
   3. Condensation Resistance Factor: Minimum CRF when tested in accordance with AAMA 1503.
      a. Fixed Glazing and Framing: Not less than 80.
      b. Entrance Doors: 68.
   4. Solar Heat Gain Coefficient: Maximum SHGC when tested in accordance with NFRC 200.
      a. Fixed Glazing and Framing: Not more than 0.45.
      b. Entrance Doors: Not more than 0.40.

C. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed assemblies without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
   1. Structural Sealant Joint Design:
      a. Designed to carry gravity loads of glazing.
      b. Designed to produce tensile or shear stress of less than 20 psi.
      c. Design reviewed and approved by structural-sealant manufacturer.
   2. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

2.3 BASIS OF DESIGN SYSTEMS

A. Single Source Responsibility: To ensure quality of appearance and performance, obtain materials for all glazed framing and entrance systems specified in this Section from a single manufacturer, capable of providing all specified systems with same profile dimensions and extrusion profiles as Basis of Design.

B. Manufacturers: Subject to specified requirement, provide Basis of Design or equivalent system as approved by Architect:
   1. Kawneer Company.
   2. VistaWall International.
C. (AFS-1), (AFS-2) and (AFS-3) Aluminum Curtain Wall Systems: High-performance extruded profile aluminum framing, thermally-broken with interior tubular section insulated from exterior pressure plate; matching stops and mullion caps; with structural-sealant-glazed where indicated; special mullion cap profiles as indicated; internal weep drainage system: glass and glazing, doors and door frames.
   1. Basis of Design: 1600 UT Wall by Kawneer.
   2. Configurations:
      a. (AFS-1): Captured glazing system with special shape mullion caps and structural sealant glazing where shown. Internally reinforced.
      b. (AFS-2): Structural sealant glazed system.
      c. (AFS-3): Captured glazing system with 6-inch deep mullion caps.
   3. Finish: Color Anodized, AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

D. (AFS-4) Aluminum Storefront Systems: Thermally-broken aluminum framing and entrances, designed to accept 1 inch glazing material; matching stops and mullion caps; with structural-sealant-glazed where indicated.
   2. Finish: Color Anodized, AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

   1. Profiles: 4-inch medium stiles, 4-inch top rail, and 10-inch bottom rail.
   2. Door Construction: 1-3/4-inch overall depth, with minimum 3/16-inch-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
      a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
      b. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
   3. Framing Members: Manufacturer's standard extruded aluminum, minimum 0.125 inch thick and reinforced as required to support imposed loads.
      a. Nominal Size: As indicated on Drawings.
      b. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
   4. Finish: Color Anodized, AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
   5. Door Hardware: As specified in Section 087100 - Door Hardware.
      a. Hinges shall be minimum 5 knuckle ball bearing type, 2 pair per door leaf. Doors that open out of the occupied space shall have two non-removable hinge pins - top and bottom. Continuous hinges shall be used on all exterior doors, including main entrance and vestibule doors.
   6. Entrance doors and frames shall be prepared for building security systems prior to installation. Preparation prior to installation of frames and doors shall be the responsibility of the frame and door provider.

2.4 SYSTEM COMPONENTS & MATERIALS

A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   1. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
2. Jamb Receptors: Provide as shown on Drawings.
3. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209.
   b. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221.
   d. Structural Profiles: ASTM B 308/B 308M.
4. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

B. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
1. Structural Shapes, Plates, and Bars: ASTM A 36.
2. Cold-Rolled Sheet and Strip: ASTM A 611.

Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
4. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
5. Reinforce members as required to receive fastener threads.
6. Fasteners Exposed to Weather: 300 Series stainless steel, type and size recommended by curtain wall manufacturer with exposed portions matching finish curtain wall system.
7. Silicone Sheet Flashing: Extruded or preformed silicone weather-barrier transition sheet recommended by curtain wall manufacture.

C. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123 or ASTM A 153 requirements.

D. Accessories:
1. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
2. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.
3. Sealant: Comply with Section 079000 - Joint Protection for weatherseal sealant and backing rod.

E. Insulated Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
1. Overall Panel Thickness: As indicated.
2. Exterior Skin, Both Faces: Aluminum sheet, Manufacturer's standard thickness for finish and texture indicated.
   a. Texture: Smooth.
3. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.
4. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 450 or less.

F. Glazing: Comply with Section 088000 - Glazing for the following:
1. Glass and Glazing
2. Glazing Gaskets
3. Glazing Sealants
4. Structural Glazing Sealants

2.5 FABRICATION

A. Aluminum Framing: Fabricate framing components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Provisions for field replacement of glazing from exterior.
   6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   7. Components curved to indicated radii.
   8. Conceal fasteners wherever possible.
   9. Reinforce work as necessary for performance requirements, and for support to structure.
   10. Separate dissimilar metals and aluminum in contact with concrete utilizing protective coating or preformed separators, which will prevent contact and corrosion.
   11. Comply with Section 088000 for glazing requirements.
   12. Shop-fabricate and assemble to greatest extent possible.
   13. Maintain accurate relation of planes and angles, with hairline fit of contacting members.
   14. Seal horizontals and direct moisture accumulation to exterior.
   15. Provide flashings and other materials used internally or externally that are corrosive resistant, non-staining, non-bleeding and compatible with adjoining materials.
   16. Provide manufacturer's extrusions and accessories to accommodate expansion and contraction due to temperature changes without detrimental to appearance or performance.

B. Welding:
   2. Use recommended electrodes and methods to avoid distortion and discoloration.
   3. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
   4. Grind exposed welds smooth and flush with adjacent surfaces; restore mechanical finish.

C. Flashing: Form from sheet aluminum with same finish as extruded sections. Apply finish after fabrication. Material thickness as required to suit condition without deflection or "oil-canning".

D. Entrances:
   1. Door Frames: Fabricate tubular and channel frame assemblies, as indicated, with either welded or mechanical joints in accordance with manufacturer's standards, reinforced as necessary to support required loads. Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
      a. At exterior doors, provide compression weather stripping at fixed stops.
      b. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
2. Stile-and-Rail Doors: Provide tubular frame members, fabricated with mechanical joints using heavy inserted reinforcing plates and concealed tie-rods or j-bolts, or fabricate with structurally welded joints, at manufacturer's option. Reinforce doors as required for installing entrance door hardware.
   a. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
   b. At exterior doors, provide weather sweeps applied to door bottoms.

3. Glazing: Fabricate doors to facilitate replacement of glass or panels, without disassembly of door stiles and rails. Provide snap-on extruded aluminum glazing stops, with exterior stops anchored for non-removal.

4. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

E. Form or extrude aluminum shapes before finishing.

F. Other Finishes:
   1. Concealed Steel Items: Galvanized in accordance with ANSI/ASTM A653 to 2.0 oz/sq ft primed with iron oxide paint.
   2. Apply one coat of bituminous paint to concealed aluminum and steel surfaces in contact with cementitious or dissimilar materials.
   3. Primer: FS TT-P-31; for shop application and field touch-up.
   4. Touch-Up Primer for Galvanized Surfaces: FS TT-P-641; TT-P-645.

2.6 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify wall openings and adjoining air and vapor seal materials are ready to receive work of this Section.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.
   3. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

A. Coordinate dimensions, tolerances, and method of attachment with other work.
   1. Variation from Plane: 0.06 inches every 3 feet maximum or 0.25 inches per 100 feet, whichever is less.
   2. Misalignment of Two Adjoining Members Abutting in Plane: 0.015 inches.

B. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

A. General:
1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Install components plumb and level, securely anchored, and without warp, twist or other distortion.
   a. Maintain assembly dimensional tolerances, aligning with adjacent work.
5. Install components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.
6. Adjust weather-stripping contact and hardware movement to provide specified performance and proper operation.
7. Provide thermal isolation where components penetrate insulation.
8. Coordinate attachment and seal of air and vapor retarder materials. Install sill flashings.
9. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

B. Metal Protection:
1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Anchorage: Provide alignment attachments and shims required to permanently fasten system to building structure as indicated on Shop Drawings.
1. Use method of attachment to structure permitting sufficient adjustment to accommodate construction tolerances and irregularities.
2. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
3. Provide separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

D. Welding: Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
1. Do not cut, trim, weld or braze component parts during erection in manner which would damage finish, decrease strength, or result in visual imperfection or failure in performance. Return component parts which require alteration to shop prefabrication, if possible, or for replacement with new parts.

E. Install glass and glazing and glazed-in metal panels in accordance with Section 088000.

F. Install perimeter sealant and backing materials in accordance with Section 079000.

G. Erection Tolerances: Install structural-sealant-glazed curtain walls to comply with the following maximum tolerances:
1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:
   a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
   b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
   c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.
3.4 FIELD TESTING

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field Quality Control, General: Perform field quality control testing to measure performance of installed curtain wall assemblies and to set standards for workmanship and quality of subsequent assembly installation.
   1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
   2. Reports: Prepare test and inspection reports. Submit in accordance with Section 013300.
   3. Repair areas damaged by testing.
   4. Curtain walls will be considered defective if they do not pass tests and inspections.

C. Test Areas: Perform the following tests on integrated mockup or on representative area of installed curtain wall, in location and of size as determined by the Architect. Test area shall include perimeter caulking, typical splices, frame intersections, and at least 2 entire lites containing an intermediate horizontal member (if applicable).

D. Air Infiltration and Water Penetration Tests: Perform field testing in accordance with AAMA 503, using same minimum static-air-pressure differential as used for laboratory testing. No field reduction allowed.
   1. Complete a minimum of three successful tests for both air infiltration and water penetration, achieving satisfactory results and meeting specified requirements.
   2. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 30, and 70 percent completion.
   3. Retesting: Make corrections to and retest area until satisfactory results are achieved.
   4. Field Testing Performance Requirements:
      a. Air Infiltration: Maximum allowable rate of air leakage shall not exceed 0.06 CFM per square foot.
      b. Water Penetration: No evidence of water penetration.

E. Structural-Sealant Adhesion Test: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.

3.5 INSTALLED WORK

A. Protection: Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the glazed wood curtain walls shall be without damage at time of Substantial Completion.
   1. Protective Coverings: Protect the work for the duration of construction. Such protection shall avoid development of non-uniformity in finishes, shall not impair a residue which would adversely affect the adhesion of sealants, nor cause other deleterious effects in the work. Temporarily remove such protection when requested by the Architect for inspection of finishes, and completely remove protection when no longer required.

B. Maintenance Instructions: Instruct the Owner’s personnel who will be responsible for window washing and snow removal after the time of final acceptance.

END OF SECTION
SECTION 08 5659 - SERVICE AND TELLER WINDOW UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Service and teller window units.

1.02 REFERENCE STANDARDS

1.03 ADMINISTRATIVE REQUIREMENTS
A. Coordinate work with adjacent materials specified in other sections and as indicated on drawings and approved shop drawings.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit manufacturer's product data for specified products indicating materials, operation, glazing, finishes, and installation instructions.
C. Shop Drawings: Indicate configuration, sizes, rough-in, mounting, anchors and fasteners, and installation clearances.
D. Test Data: Test reports for specific window model and glazing to be furnished, showing compliance with all specified requirements; window and glazing may be tested separately, provided window test sample adequately simulates the glazing to be used.
E. Samples for Selection of Finishes:
   1. Color Anodized Finishes: Submit two samples, 4 inch by 4 inch (100 mm by 100 mm) in size illustrating metal finishes for each finish specified.
F. Manufacturer Qualification Statement.
G. Installer Qualification Statement.
H. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with at least ten years documented experience, and with ability to provide test reports showing that their standard manufactured products meet the specified requirements.
B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Deliver units in manufacturer's original packaging and unopened containers with identification labels intact.
B. Store units in area protected from exposure to weather and vandalism.

1.07 WARRANTY
A. Provide manufacturer's warranty agreeing to repair or replace units and their components that fail in materials or workmanship within five years from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Service and Teller Window Units:

2.02 SERVICE AND TELLER WINDOW UNITS
A. Location:  Built within exterior wall, as indicated on drawings.
B. Type of Use: Walk-up.
C. Window Type: Sliding, single horizontal.
   3. Window Size: 47-1/2 inch wide by 43-1/2 inch high
      a. Finish: Color anodized, black. To match adjacent Curtain Wall.
D. Glazing: Single (monolithic), clear.
E. Products:

2.03 ASSEMBLY COMPONENTS
A. Windows: Factory-fabricated, finished, and glazed, with extruded aluminum frame and glazing stops; complete with hardware and anchors.
   1. Provide window units that are re-glazable from the secure side without dismantling the non-secure side of framing.
   2. Rigidly fit and secure joints and corners with internal reinforcement. Make joints and connections flush, hairline, and weatherproof. Fully weld corners.
   3. Apply factory finish to exposed surfaces.
   4. Wind Design: Design and size components to withstand dead loads and live loads caused by pressure and negative wind loads acting normal to plane of window as calculated in accordance with applicable code.

2.04 MATERIALS
A. Aluminum Extrusions: Minimum 1/8 inch (3.2 mm) thick frame and sash material complying with ASTM B221 and ASTM B221M.
B. Insulating Glass: Double pane insulating vision glass; 5/8 inch (15.9 mm) thick, minimum.
   1. Low-E coating on No. 2 surface.
C. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.

2.05 FINISHES
A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils (0.018 mm) thick.

2.06 ACCESSORIES
A. Hardware and Security Devices for Sliding Windows:

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that window openings are ready for installation of windows.
B. Verify that correct embedded anchors are in place and in proper location; repair or replace anchors as required to achieve satisfactory installation.
C. Notify Architect if conditions are not suitable for installation of units; do not proceed until conditions are satisfactory.

3.02 INSTALLATION
   A. Install in accordance with manufacturer’s instructions.
   B. Install units in correct orientation (inside/outside or secure/non-secure).
   C. Anchor units securely in manner so as to achieve performance specified.
   D. Set sill members and sill flashing in continuous bead of sealant.
   E. Remove and replace defective work.

3.03 ADJUSTING
   A. Adjust operating components for smooth operation while also maintaining a secure, weather-tight enclosure and a tight fit at the contact points; lubricate operating hardware.

3.04 CLEANING
   A. Remove protective material from factory finished surfaces.
   B. Clean exposed surfaces promptly after installation without damaging finishes.

3.05 DEMONSTRATION
   A. Train Owner’s maintenance personnel to adjust, operate, and maintain operable units.
      1. Instructor: Manufacturer’s training personnel.
      2. Location: At project site.
      3. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.06 PROTECTION

END OF SECTION
SECTION 085673
SOUND CONTROL WINDOW UNITS

PART 1 GENERAL

1.1 SUMMARY
   A. Section Includes: Factory-glazed, acoustically-rated window units (SCWU).

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.
   B. Shop Drawings: Showing installation details, elevations and details of all unit sections, hardware and accessories, anchorage and hardware.

1.3 INFORMATIONAL SUBMITTALS
   A. STC Certification and Test Reports: Submit certification of Sound Transmission Class (STC) rating, along with transmission loss values within individual 1/3 octave band frequencies, for all acoustical doors with glazing and other details, performed by an accredited independent acoustical laboratory. Testing shall be in accordance with the latest version of ASTM-E90.
   B. Letter of certification stating that partition framing is suitable for the installation and proper operation and acoustic performance.
   C. Field quality-control reports.

1.4 QUALITY ASSURANCE
   A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports, and calculations.
   B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Deliver products in manufacturer's original packaging. Store materials indoors in location that is secure, dry, and has stable temperature. Handle in accordance with manufacturer's instructions to prevent damage.
   B. Use special care in handling to prevent twisting, warping, nicking, and other damage.

1.6 SITE CONDITIONS
   A. Field Measurements: Where work is indicated to fit to other construction, verify dimensions of other construction by field measurement before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.
      1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurement before being enclosed and indicate measurements on shop drawings.
1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure to meet performance requirements.
      b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
      c. Faulty operation of movable sash and hardware.
      d. Deterioration of materials and finishes beyond normal weathering.
      e. Failure of insulating glass.

PART 2 PRODUCTS

2.1 SOUND-CONTROL ALUMINUM WINDOWS

A. Single Source: All components to be products supplied by the single manufacturer, and shall comply with specified laboratory acoustical ratings as tabulated at end of this section.

B. Manufacturers:
   1. Milco
   2. Mon-Ray Inc.
   3. Peerless Products

C. Aluminum-framed, factory-glazed window units; acoustically tested & rated; prefinished matte black. Provide in sizes and configurations as indicated on Drawings and as described below.

D. (SCWU-1) Fixed Units: At Control Room.
   1. Basis of Design: DeVAC 650-AL by Mon-Ray Inc.
   2. (GL-12) Laminated Clear Glass: 1/2-inch unit consisting of 2 plies of 1/4-inch, heat-treated clear glass, laminated with 0.090-inch clear PVB Interlayer.
   3. Sound Transmission Class (STC): Rated for not less than STC 32 when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.

E. (SCWU-2) Fixed Units: At Projection.
   1. Basis of Design: DeVAC 650-AL by Mon-Ray Inc.
   2. (GL-5) Non-Reflective, Ultra-Clear Glass: Glass Substrate: 3/8-inch thick, ultra-clear, low-iron float glass with a visible light transmission exceeding 90 percent through a 6.0mm test sample; select glazing quality (q3), Type I, Class I, free of defects that affect normal viewing.
      a. Anti-Reflective Coating: On each face, providing residual reflection of less than 1 percent when viewed at a 90 degree angle.
   3. Sound Transmission Class (STC): Rated for not less than STC 32 when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.

F. (SCWU-2) Operable Units: At Control Room.
   1. Basis of Design: DeVAC 650-AL-2E by Mon-Ray Inc.
   2. (GL-12) Laminated Clear Glass: 1/2-inch unit consisting of 2 plies of 1/4-inch, heat-treated clear glass, laminated with 0.090-inch clear PVB Interlayer.
   3. Sound Transmission Class (STC): Rated for not less than STC 50 when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
G. Frames and Sashes: Extruded aluminum shapes, aluminum alloy 6063-T6 Architectural Grade homogenized aluminum primary billet, minimum nominal wall thickness of .062”, except frame sills which have a nominal wall thickness of .093” in the primary walls and track.

H. Frame Finish: Provide with Manufacturer’s standard color-anodized or fluoropolymer finish, and in accordance with the following:
   1. Color-Anodized Finish: Class I, AA-M12C22A42/A44; nonspecular as fabricated mechanical finish; etched, medium matte chemical finish.
   2. Fluoropolymer Finish: High-performance, two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.

I. Thermal Barrier: Tongue and groove fit to aluminum extrusions, minimum 1/4-inch wide. No screws, connections or fittings span the thermal barrier. Provides complete metal separation of the frame members.

J. Weather-stripping: Double weather-stripped silicone-coated woven pile with mylar side fins or center fins.
   1. Silicone treated; UV stabilized polypropylene pile with an integral polypropylene fin running through the center; bonded to a non-shrinking backing, which shall slide into extruded ports in the aluminum frame and sash. All weather-strip shall be staked in place.
   2. Vinyl weather-stripping will not be accepted.

K. Glazing Gasket: Silicone or closed-cell neoprene to meet performance requirements

L. Hardware: Spring loaded stainless steel plunger lock. Interior meeting rails to have continuous grip rails.

M. Perimeter Sealant: Non-hardening acoustic sealant as specified in Section 092900 - Gypsum Board.

2.2 FABRICATION

A. Window Unit Construction: Identical to that of the acoustically tested unit.

B. Shop-fabricate complete unit, including glazing.
   1. Entire unit including frame, seals, glass and mullions shall be factory fabricated and shipped to site ready for installation in roughed opening.
   2. Window system shall include: glass, steel framing and trim, and all accessory items as shown on the drawings and required for a complete installation, including caulking and anchorage to adjacent construction.

C. Framing: Continuous extrusions, square cut at corners and precision machined, with continuous non-conductive rigid vinyl thermal barrier.
   1. Corners fastened with minimum of four stainless steel screws.
   2. Sill is tubular and weeped to prevent the accumulation of moisture or debris. The weep system allows drainage of water from cavities in sill.
   3. Sill section allows for anchorage without bridging thermal barrier.

D. Sash: Hollow tubular extrusions, square cut and milled to allow telescoped joints at each corner.
   1. Screws, axles and pins are stainless steel.
   2. Sashes are removable from inside, without tools, for cleaning.
PART 3 EXECUTION

3.1 EXAMINATION
A. Examination and Acceptance of Conditions: Before proceeding with installation, examine conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Space Requirements: Take field measurements as required to fit the Work properly. Verify space requirements and dimensions of items shown diagrammatically on Drawings.

B. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. General: Comply with manufacturer’s written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer’s written instructions, comply with installation requirements in ASTM E 2112.
   1. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
   2. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
   3. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

B. Comply with manufacturer’s written instructions and recommendations for installing products in applications indicated.

C. Attachment: Provide blocking, attachment plates, anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

D. Sealant: Seal joints between windows and surrounding construction with non-hardening sealant.
   1. Provide joint backing in all joints where a suitable backstop to receive sealant is otherwise not available.
   2. Pack joints with joint backing to provide depth equal to 1/2 of width. Caulk joint width cannot be less than 1/4” nor more than 1/2” unless recommended otherwise by the manufacturer.

3.3 FIELD TESTING VERIFICATION
A. If required, the owner will retain the services of an independent acoustical consultant to conduct field sound transmission tests at any designated window locations where acoustical performance is suspected by the architect of not being in compliance with these specifications. The tests shall be conducted in accordance with ASTM E-336 to determine the Field Sound Transmission Class (FSTC) or Noise Isolation Class (NIC), as applicable and feasible. If such results indicate acoustical performance more than 5 points less than the specified STC ratings, it shall be the responsibility of the manufacturer and contractor, at their expense, to correct such deficiencies by methods approved by the architect prior to incorporation. Sound transmission tests shall be repeated and corrective measures implemented until the established performance requirements are met. If the architect determines that the materials are not as specified herein, all costs for the initial tests, as well as costs for retesting, shall be borne by the contractor and manufacturer.
3.4 INSTALLED WORK

A. Adjusting Operable Components: Adjust movable components of assembly to operate safely, smoothly, easily, and quietly, free from binding, warp, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range, and without binding or damaging assembly components. Lubricate hardware and moving parts.

B. Cleaning: Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period.

C. Protection: Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

END OF SECTION
SECTION 087100 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:
   1. Swinging doors.
   2. Sliding doors.
   3. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:
   1. Mechanical door hardware.
   2. Electromechanical door hardware.
   3. Automatic operators.
   4. Cylinders specified for doors in other sections.

C. Related Sections:
   1. Division 08 Section “Door Hardware Schedule”.
   2. Division 08 Section “Hollow Metal Doors and Frames”.
   3. Division 08 Section “Flush Wood Doors”.
   4. Division 08 Section “Aluminum-Framed Entrances and Storefronts”.
   5. Division 28 Section “Access Control”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
   6. NFPA 105 - Installation of Smoke Door Assemblies.

E. Standards: All hardware specified herein shall comply with the following industry standards:
1. ANSI/BHMA Certified Product Standards - A156 Series
2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTIALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.

3. Content: Include the following information:
   a. Type, style, function, size, label, hand, and finish of each door hardware item.
   b. Manufacturer of each item.
   c. Fastenings and other pertinent information.
   d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
   e. Explanation of abbreviations, symbols, and codes contained in schedule.
   f. Mounting locations for door hardware.
   g. Door and frame sizes and materials.
   h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
b. Complete (risers, point-to-point) access control system block wiring diagrams.
c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

E. Proof of Compliance: (California located Projects): Provide a list of product(s) containing chemicals known to cause cancer or reproductive toxicity as defined by the Office of Environmental Health Hazard Assessment (OEHHA) under Proposition 65 (CA Code of Regulations, Title 27, Section 27001). The list includes the specific chemical(s), if the chemical will be exposed to consumers, the means of warning, and an illustration of the label.

F. Informational Submittals:
   1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

G. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during
the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

D. Door Hardware Standards and Guidelines: Prepare Door Hardware specification documents in accordance with the Owner's approved ASSA ABLOY Virtual Design Guide (VDG) standard for door opening products and applications.

E. Building Information Modeling (BIM) Qualifications: BIM software tools and processes are used to produce and support data integration of product and technical information used in specifications, submittals, project reviews, decision support, and quality assurance during all phases of Project design, construction, and facility management. Door and hardware schedules and the associated product data parameters are to be derived, updated, and fully integrated with the coordinated BIM.

1. Door Hardware BIM Software Tool: Openings Studio™ is the designated BIM software suite to be used in a coordinated effort with architects, contractors and trades to integrate Project product data and information into the coordinated Record BIMs and associated applications.

F. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

G. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

H. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

I. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors.
Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.

2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.

3. Review sequence of operation narratives for each unique access controlled opening.

4. Review and finalize construction schedule and verify availability of materials.

5. Review the required inspecting, testing, commissioning, and demonstration procedures

J. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

D. Building Information Modeling (BIM) Support: Utilize designated BIM software tools and obtain training needed to successfully participate in the Project BIM processes. All technical disciplines are responsible for the product data integration and data reliability of their Work into the coordinated BIM applications.
1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:

1. Ten years for mortise locks and latches.
2. Five years for exit hardware.
3. Twenty five years for manual surface door closer bodies.
4. Five years for motorized electric latch retraction exit devices.
5. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:
   a. Two Hinges: For doors with heights up to 60 inches.
   b. Three Hinges: For doors with heights 61 to 90 inches.
   c. Four Hinges: For doors with heights 91 to 120 inches.
   d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
   a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
   b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
   a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
   b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:
   a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:
   a. Hager Companies (HA) - CB Series.
   b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - MacPro Series.
   c. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - TA Series.
d. Stanley Hardware (ST) - CB Series.

B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:
   a. Hager Companies (HA).
   b. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
   c. Stanley Hardware (ST).

C. Pin and Barrel Continuous Hinges: ANSI/BHMA A156.26 Grade 1-600 certified pin and barrel continuous hinges with minimum 14 gauge Type 304 stainless steel hinge leaves, concealed teflon coated stainless pin, and twin self-lubricated nylon bearings at each knuckle separation. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:
   a. Hager Companies (HA).
   b. Markar Products; ASSA ABLOY Architectural Door Accessories (MR).
   c. Stanley Hardware (ST).

2.3 POWER TRANSFER DEVICES

A. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:
   a. Securitron (SU) - EL-CEPT Series.
   b. Von Duprin (VD) - EPT-10 Series.

2.4 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

5. Manufacturers:

   a. Burns Manufacturing (BU).
   b. Ives (IV).
   c. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

B. Coordinators: ANSI/BHMA A156.3 certified door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.

   1. Manufacturers:

      a. Burns Manufacturing (BU).
      b. Ives (IV).
      c. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

C. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

   1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
   2. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
   3. Leather: Where specified English bridle and Italian Upholstery shall be 10 ounce with hand sewn saddle stitches and hand sewn end line stitches.
   4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.

   5. Manufacturers:

      a. Burns Manufacturing (BU).
      b. Hiawatha, Inc. (HI).
      c. Ives (IV).
      d. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

2.5 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

   1. Manufacturers:

      a. Stanley Best (BE).
      b. No Substitution.

B. Cylinders: Original manufacturer cylinders complying with the following:
1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.

C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
   1. Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.

D. Keying System: Each type of lock and cylinders to be factory keyed.
   1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.
   2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
   3. Existing System: Field verify and key locks to match Owner's existing system.

E. Key Quantity: Provide the following minimum number of keys:
   1. Change Keys per Cylinder: Three (3).
   2. Master Keys (per Master Key Level/Group): Five (5).
   4. Construction Control Keys (where required): Two (2).
   5. Permanent Control Keys (where required): Two (2).

F. Construction Keying: Provide temporary keyed construction cores.

G. Key Registration List (Bitting List):
   1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
   2. Provide transcript list in writing or electronic file as directed by the Owner.

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.
   1. Extended cycle test: Locks to have been cycle tested in ordinance with ANSI/BHMA 156.13 requirements to 10 million cycles.
   2. Provide status indicators with highly reflective color and wording for “locked/unlocked” or “vacant/occupied” with custom wording options if required. Indicator to be located
above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status. Indicator window size to be a minimum of 2.1” x 0.6” with a curved design allowing a 180 degree viewing angle with protective covering to prevent tampering.

3. Manufacturers:

2.7 ELECTROMECHANICAL LOCKING DEVICES

A. Electromechanical Mortise Locksets, Grade 1 (Heavy Duty): Subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below.

1. Electrified Lock Options: Where indicated in the Hardware Sets, provide electrified options including: outside door lock/unlock trim control, latchbolt and lock/unlock status monitoring, deadbolt monitoring, and request-to-exit signaling. Support end-of-line resistors contained within the lock case. Unless otherwise indicated, provide electrified locksets standard as fail secure.

2. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.

3. Manufacturers:
   a. Corbin Russwin Hardware (RU) - ML20900 Series.

2.8 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.

3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.

5. Flush End Caps: Provide flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.

6. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.

7. Electromechanical Options: Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified in hardware sets. Include any specific controllers when conventional power supplies are not sufficient to provide the proper inrush current.

8. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
   a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
   b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

9. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.

10. Rim Exit Devices: Exit device rails shall release with less than 5 pounds of pressure per the California Building Code.

11. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.


13. Rail Sizing: Provide exit device rails factory sized for proper door width application.

14. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty) at Exterior Doors: ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

   1. Manufacturers:
      a. Von Duprin (VD) - 98 Series.
      b. No Substitute.
C. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

1. Manufacturers:
   a. Sargent Manufacturing (SA) - 80 Series.
   b. Von Duprin (VD) - 98 Series.

2.9 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.

2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.

4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.

5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers – Exterior Doors, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Manufacturers:
   a. LCN Closers (LC) - 4040XP Series.
C. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

1. Manufacturers:
   a. Corbin Russwin Hardware (RU) - DC6000 Series.
   b. LCN Closers (LC) - 4040 Series.
   c. Norton Door Controls (NO) - 7500 Series.

2.10 ELECTROHYDRAULIC DOOR OPERATORS

A. General: Provide low energy operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for compliance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation devices.

1. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.

B. Standard: Certified ANSI/BHMA A156.19.

C. Performance Requirements:

1. Opening Force if Power Fails: Not more than 15 lbf required to release a latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.

2. Entrapment Protection: Not more than 15 lbf required to prevent stopped door from closing or opening.

D. Configuration: Surface mounted or in-ground as required. Door operators to control single swinging and pair of swinging doors.

E. Operation: Power opening and spring closing operation capable of meeting ANSI A117.1 accessibility guideline. Provide time delay for door to remain open before initiating closing cycle as required by ANSI/BHMA A156.19. When not in automatic mode, door operator to function as manual door closer with fully adjustable opening and closing forces, with or without electrical power.

F. Features: Operator units to have full feature adjustments for door opening and closing force and speed, backcheck, motor assist acceleration from 0 to 30 seconds, time delay, vestibule interface delay, obstruction recycle, and hold open time from 0 up to 30 seconds.

G. Provide outputs and relays on board the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.
H. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonferrous shims for aligning system components.

I. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Dorma Products (DO) - ED800 Series.
2. LCN Closers (LC) - 4640 Series.

2.11 SURFACE MOUNTED CLOSER HOLDERS

A. Electromagnetic Door Holders: Certified ANSI A156.15 electromagnetic door holder/releases with a minimum 20 to 40 pounds holding power and single coil construction able to accommodate 12VDC, 24VAC, 24VDC and 120VAC. Coils to be independently wound, employing an integral fuse and armatures to include a positive release button.

1. Manufacturers:
   a. LCN Door Closers (LC) - SEM7800 Series.
   b. Rixson (RF) - 980/990 Series.

2.12 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.

2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.

4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
   a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.

6. Manufacturers:
2.13 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:
   a. Hager Companies (HA).
   b. Hiawatha, Inc. (HI).
   c. Ives (IV).
   d. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:
   a. Glynn Johnson (GJ).
   b. Rixson Door Controls (RF).

2.14 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
   1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:
   1. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
   2. Reese Enterprises, Inc. (RE).

2.15 ELECTRONIC ACCESSORIES

A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.
   1. Manufacturers:
      a. Sentrol.

B. Power Supplies: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Include battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw plus 50% for the specified electrified hardware and access control equipment.
   1. Manufacturers:
      a. Securitron (SU) - BPS Series.
      b. Von Duprin (VD) - PS.

2.16 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.
2.17 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.


3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

   1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection (Punch-Out Report): Reference Division 01 Section "Closeout Procedures". Final inspect installed door hardware and state in report whether work complies with or deviates from specification requirements, including whether door hardware is properly installed, operating and adjusted.

B. Fire Door Assembly Inspection: Reference Division 01 Sections "Closeout Procedures" and "Cash Allowances" for testing and inspection allowances, including cost of engaging testing agencies, performing on-site inspections, and required documentation reporting.

1. Allowance to perform the inspection and provide report documentation for an initial Fire Door Assembly Inspection upon completion of final hardware installation. A qualified fire door assembly (FDAI) inspector to certify swinging fire door openings are installed in accordance and NFPA 80 Standard for Fire Doors and Other Opening Protectives paragraph 5.2.4, regulatory compliance agencies, and local Authorities Having Jurisdiction (AHJ).

C. Opening Tags: Affix readable, QR-type label to openings with password protected link-out to Openings Studio™ BIM software suite and the installed door and hardware information.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door.

C. MATERIALS ARE SPECIFIED IN ACCORDANCE WITH THE PREMIER/ASSA ABLOY GPO CONTRACT #PP-FA-663.

D. Manufacturer’s Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. MR - Markar
4. RF - Rixson
5. RO - Rockwood
6. OT - Other
7. VD - Von Duprin
8. SA - SARGENT
9. RU - Corbin Russwin
10. BE - dormakaba Best
11. GJ - Glynn-Johnson
12. LC - LCN Closers
13. SU - Securitron

**Hardware Sets**

**Set: 1.0**

Doors: 1290.02

<table>
<thead>
<tr>
<th>Hardware Item</th>
<th>Model/Description</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Hinge</td>
<td>CFM-SLF-HD1 x PT</td>
<td>PE</td>
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<tr>
<td>Exit Device (nightlatch)</td>
<td>LX-RX-LC SD-EL 98NL less pull</td>
<td>US26D</td>
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<td>Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
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<tr>
<td>Rim Cylinder</td>
<td>- match Owner's existing Best key system</td>
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<td>Pull</td>
<td>RM201 Mtg-Type 12XHD</td>
<td>US32D-316 RO</td>
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<td>630</td>
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<td>AL</td>
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<td>Threshold</td>
<td>279x292AFGPK x MSES25SS</td>
<td>PE</td>
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<tr>
<td>Weatherstrip</td>
<td>- integral within construction of door and frame assembly</td>
<td>00</td>
</tr>
<tr>
<td>Door Sweep</td>
<td>29326CNB x TKSP8</td>
<td>PE</td>
</tr>
<tr>
<td>Door Contact</td>
<td>1078D (DPDT) - 1&quot; diameter concealed</td>
<td>OT</td>
</tr>
<tr>
<td>Electric Power Transfer</td>
<td>EPT10</td>
<td>SP28</td>
</tr>
<tr>
<td>Power Supply</td>
<td>PS914 x 900-2RS (electric latch retraction)</td>
<td>VD</td>
</tr>
<tr>
<td>Card Reader</td>
<td>- Provided by Security Contractor</td>
<td>00</td>
</tr>
</tbody>
</table>

**Notes:**
Door normally closed and locked. Key override outside retracts latch bolt of exit device. Valid use of card reader outside or activation of remote switch (intercom system) will electronically retract latch of exit device to gain entry. Exit device equipped with signal switch in push rail to act as shunt for door monitoring upon egress. Free egress always permitted.

**Set: 2.0**

Doors: 1290.01A
<table>
<thead>
<tr>
<th>Item Description</th>
<th>Model/Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Continuous Hinge</td>
<td>BLFM-SLF-HD1 x PT</td>
<td>PE</td>
</tr>
<tr>
<td>1 Mullion</td>
<td>KR9954</td>
<td>SP28 VD</td>
</tr>
<tr>
<td>1 Exit Device (nightlatch)</td>
<td>LX-RX-LC SD-EL 98NL less pull 622 VD</td>
<td></td>
</tr>
<tr>
<td>1 Exit Device (exit only)</td>
<td>LX-RX-LC SD-EL 98EO 622 VD</td>
<td></td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system BL BE</td>
<td></td>
</tr>
<tr>
<td>1 Rim Cylinder</td>
<td>- match Owner's existing Best key system BL BE</td>
<td></td>
</tr>
<tr>
<td>2 Pull</td>
<td>RM2400-72 Mtg-Type 12XHD BSP RO</td>
<td></td>
</tr>
<tr>
<td>2 Surf Overhead Stop</td>
<td>10-X36 x ADJ BSP RF</td>
<td></td>
</tr>
<tr>
<td>1 Drop Plate</td>
<td>4040XP-18TJ BLACK LC</td>
<td></td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>4040XP REG/LONG BLACK LC</td>
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</tr>
<tr>
<td>1 Door Operator</td>
<td>4642 REG/LONG - confirm head detail BLACK LC</td>
<td></td>
</tr>
<tr>
<td>1 Threshold</td>
<td>1715BSP MSES25SS PE</td>
<td></td>
</tr>
<tr>
<td>1 Weatherstrip</td>
<td>- integral within construction of door and frame assembly 00</td>
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</tr>
<tr>
<td>1 Door Sweep</td>
<td>29326BSPNB TKSP PE</td>
<td></td>
</tr>
<tr>
<td>2 Door Contact</td>
<td>1078D (DPDT) - 1&quot; diameter concealed OT</td>
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</tr>
<tr>
<td>1 Pedestal</td>
<td>- to house card reader and exterior ADA operator switch OT</td>
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<tr>
<td>2 Electric Power Transfer</td>
<td>EPT10 SP28 VD</td>
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</tr>
<tr>
<td>2 Actuator</td>
<td>8310-856 LC</td>
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</tr>
<tr>
<td>1 Power Supply</td>
<td>PS914 x 900-2RS (electric latch retraction) VD</td>
<td></td>
</tr>
<tr>
<td>1 Card Reader</td>
<td>- Provided by Security Contractor 00</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Door normally closed and locked. Key override outside retracts latch bolt of exit device. Valid use of card reader outside will electronically retract latch of exit device. Door may be unlocked (latch retracted electronically) upon schedule as determined in access control system. Exit device equipped with signal switch in push rail to act as shunt for door monitoring upon egress. Outside ADA actuator switch will not cycle automatic operator unless latch bolt is retracted (may utilize latch bolt monitor switch for this function). Inside ADA actuator switch automatically retracts latch of exit device and cycles automatic operator. Free egress always permitted.

**Set: 3.0**

Doors: 1290.01B

2 Continuous Hinge | BLFM-SLF-HD1 x PT | PE |
<table>
<thead>
<tr>
<th>Item Description</th>
<th>Model/Details</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mullion</td>
<td>KR9954</td>
<td>SP28</td>
<td>VD</td>
</tr>
<tr>
<td>Exit Device (exit only)</td>
<td>LX-RX-LC SD-EL 98EO</td>
<td>622</td>
<td>VD</td>
</tr>
<tr>
<td>Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>Pull</td>
<td>RM2400-72 Mtg-Type 12XHD</td>
<td>BSP</td>
<td>RO</td>
</tr>
<tr>
<td>Surf Overhead Stop</td>
<td>10-X36 x ADJ</td>
<td>BSP</td>
<td>RF</td>
</tr>
<tr>
<td>Drop Plate</td>
<td>4040XP-18TJ</td>
<td>BLACK</td>
<td>LC</td>
</tr>
<tr>
<td>Surface Closer</td>
<td>4040XP REG/LONG</td>
<td>BLACK</td>
<td>LC</td>
</tr>
<tr>
<td>Threshold</td>
<td>1715BSP MSES25SS</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Weatherstrip</td>
<td>- integral within construction of door and frame assembly</td>
<td>00</td>
<td></td>
</tr>
<tr>
<td>Door Sweep</td>
<td>29326BSPNB TKSP</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Door Contact</td>
<td>1078D (DPDT) - 1&quot; diameter concealed</td>
<td>OT</td>
<td></td>
</tr>
<tr>
<td>Electric Power Transfer</td>
<td>EPT10</td>
<td>SP28</td>
<td>VD /ới</td>
</tr>
<tr>
<td>Power Supply</td>
<td>PS914 x 900-2RS (electric latch retraction)</td>
<td>VD /ới</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Door normally closed and locked. Door may be unlocked (latch retracted electronically) upon schedule as determined in access control system. Exit device equipped with signal switch in push rail to act as shunt for door monitoring upon egress. Free egress always permitted.

Set: 4.0

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Model/Details</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Hinge</td>
<td>CFM-SLF-HD1</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Exit Device (Nightlatch)</td>
<td>CD 98NL</td>
<td>US26D</td>
<td>VD</td>
</tr>
<tr>
<td>Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>Rim Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>Surface Closer</td>
<td>DC8220 top jamb x mounting plate to suit application</td>
<td>689</td>
<td>RU</td>
</tr>
<tr>
<td>Threshold</td>
<td>279x292AFGPK x MSES25SS</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Weatherstrip</td>
<td>- integral within construction of door and frame assembly</td>
<td>00</td>
<td></td>
</tr>
<tr>
<td>Door Sweep</td>
<td>29326CNB x TKSP</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Door Contact</td>
<td>1078D (DPDT) - 1&quot; diameter concealed</td>
<td>OT</td>
<td></td>
</tr>
</tbody>
</table>

Set: 5.0

1 Continuous Hinge  CFM-HD1 x PT PE
1 Rim Exit Device  LX-RX-LC 98L E 996L-06 US26D VD
1 Rim Cylinder  - match Owner's existing Best key system 626 BE
1 Surface Closer  DC6210 A4 689 RU
1 Kick Plate  K1050 10" high BEV CSK US32D RO
1 Threshold  279x224AFGT x MSES25SS PE
1 Weatherstrip  2891APK x TKSP8 - head and jambs PE
1 Rain Guard  346C TKSP8 PE
1 Door Bottom  216BDCFG x TKSP8 PE
1 Door Contact  1078D (DPDT) - 1" diameter concealed OT
1 Electric Power Transfer  EPT10 SP28 VD ⚡
1 Power Supply  PS902 VD ⚡
1 Card Reader  - Provided by Security Contractor 00

Notes: Door normally closed and locked. Key override outside retracts latch bolt. Valid use of card reader outside temporarily unlocks outside lever for access. Push rail equipped with signal switch for request to exit alarm shunt (REX). Free egress always permitted.

Set: 6.0

Doors: 1290.05A

1 Continuous Hinge  CFM-HD1 x PT PE
1 Exit Device (nightlatch)  RX-LC SD-EL 98NL less pull US10B VD
1 Mort. Cylinder  - match Owner's existing Best key system 626 BE
1 Rim Cylinder  - match Owner's existing Best key system 626 BE
1 Vandal Resistant Trim  VRT22 C US32D RO
1 Conc Overhead Stop  1-X36 652 RF
1 Drop Plate  4040XP-18TJ AL LC
1 Surface Closer  4040XP REG/LONG AL LC
1 Kick Plate  K1050 10" high BEV CSK US32D RO
1 Threshold 279x292AFGPK x MSES25SS PE
1 Rain Guard 346C TKSP PE
1 Adjustable Sound Seal 379CS TKSP - head and jambs PE
1 Door Bottom 216BCFG x TKSP8 PE
1 Door Contact 1078D (DPDT) - 1" diameter concealed OT
1 Power Supply PS914 x 900-2RS (electric latch retraction) VD

Notes:

Set: 7.0

Doors: 1290.19A, 2315.02

1 Continuous Hinge CFM-HD1 x PT PE
1 Exit Only LX-RX-LC 98EO US26D VD
1 Surface Closer 4040XP SCUSH AL LC
1 Kick Plate K1050 10" high BEV CSK US32D RO
1 Threshold 279x292AFGPK x MSES25SS PE
1 Weatherstrip 2891APK x TKSP8 - head and jambs PE
1 Rain Guard 346C TKSP8 PE
1 Door Bottom 216BCFG x TKSP8 PE
1 Door Contact 1078D (DPDT) - 1" diameter concealed OT

Notes: Door normally closed and locked. Exit device equipped with REX signal switch in push rail for shunting of door monitoring upon egress. Free egress always permitted.

Set: 8.0

Doors: 1340.01

1 Continuous Hinge CFM-SLF-HD1 x PT PE
1 Exit Device (nightlatch) LX-RX-LC SD-EL 98NL less pull US26D VD
1 Mort. Cylinder - match Owner's existing Best key system 626 BE
1 Rim Cylinder - match Owner's existing Best key system 626 BE
1 Vandal Resistant Trim VRT22 C US32D RO

DOOR HARDWARE 087100 - 25
<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Description</th>
<th>Finish</th>
<th>Grade</th>
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</thead>
<tbody>
<tr>
<td>Surface Closer</td>
<td>4040XP SCUSH</td>
<td>AL</td>
<td>LC</td>
</tr>
<tr>
<td>Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>Threshold</td>
<td>279x292AFGPK x MSES25SS</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Weatherstrip</td>
<td>2891APK x TKSP8 - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Rain Guard</td>
<td>346C TKSP8</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Door Bottom</td>
<td>216BDCFG x TKSP8</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Door Contact</td>
<td>1078D (DPDT) - 1&quot; diameter</td>
<td>OT</td>
<td></td>
</tr>
<tr>
<td>Electric Power Transfer</td>
<td>EPT10</td>
<td>SP28</td>
<td>VD</td>
</tr>
<tr>
<td>Intercom System</td>
<td>- Provided by Security Contractor</td>
<td>OT</td>
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</tr>
<tr>
<td>Power Supply</td>
<td>PS914 x 900-2RS (electric latch retraction)</td>
<td>VD</td>
<td>⚡</td>
</tr>
<tr>
<td>Card Reader</td>
<td>- Provided by Security Contractor</td>
<td>00</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ** No intercom system at Door 1390.06A.

Door normally closed and locked. Key override outside retracts latch bolt of exit device. Valid use of card reader outside or activation of remote switch (intercom system) will electronically retract latch of exit device to gain entry. Exit device equipped with signal switch in push rail to act as shunt for door monitoring upon egress. Free egress always permitted.

Set: 9.0

Doors: 1390.01A, 1390.06A

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Description</th>
<th>Finish</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Hinge</td>
<td>CFM-SLF-HD1 x PT</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Exit Device (nightlatch)</td>
<td>LX-RX-LC SD-EL 98NL less pull</td>
<td>US26D</td>
<td>VD</td>
</tr>
<tr>
<td>Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>Rim Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>Vandal Resistant Trim</td>
<td>VRT22 C</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>Surface Closer</td>
<td>4040XP SCUSH</td>
<td>AL</td>
<td>LC</td>
</tr>
<tr>
<td>Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>Threshold</td>
<td>279x292AFGPK x MSES25SS</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Weatherstrip</td>
<td>2891APK x TKSP8 - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Rain Guard</td>
<td>346C TKSP8</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Door Bottom</td>
<td>216BDCFG x TKSP8</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Door Contact</td>
<td>1078D (DPDT) - 1&quot; diameter</td>
<td>OT</td>
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</tr>
<tr>
<td>Description</td>
<td>Model/Spec</td>
<td>Finish 1</td>
<td>Finish 2</td>
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</tr>
<tr>
<td>1 Electric Power Transfer</td>
<td>EPT10</td>
<td>SP28</td>
<td>VD</td>
</tr>
<tr>
<td>1 Intercom System</td>
<td>- Provided by Security Contractor</td>
<td>OT</td>
<td></td>
</tr>
<tr>
<td>1 Power Supply</td>
<td>PS914 x 900-2RS (electric latch retraction)</td>
<td>VD</td>
<td></td>
</tr>
<tr>
<td>1 Card Reader</td>
<td>- Provided by Security Contractor</td>
<td>00</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Door normally closed and locked. Key override outside retracts latch bolt of exit device. Valid use of card reader outside will electronically retract latch of exit device to gain entry. Exit device equipped with signal switch in push rail to act as shunt for door monitoring upon egress. Free egress always permitted.

**Set: 10.0**

<table>
<thead>
<tr>
<th>Description</th>
<th>Model/Spec</th>
<th>Finish 1</th>
<th>Finish 2</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>3 Hinge (heavy weight)</td>
<td>T4A3386 x NRP</td>
<td>US32D</td>
<td>MK</td>
<td></td>
</tr>
<tr>
<td>1 Storeroom Lock</td>
<td>ML2057 NSA LC</td>
<td>626</td>
<td>RU</td>
<td></td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
<td></td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC8200 - pull side mount</td>
<td>689</td>
<td>RU</td>
<td></td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
<td>RO</td>
<td></td>
</tr>
<tr>
<td>1 Wall Stop</td>
<td>406</td>
<td>US32D</td>
<td>RO</td>
<td></td>
</tr>
<tr>
<td>1 Threshold</td>
<td>279x292AFGPK x MSES25SS</td>
<td></td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Weatherstrip</td>
<td>2891APK x TKSP8 - head and jambs</td>
<td></td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Door Bottom</td>
<td>216BDCFG x TKSP8</td>
<td></td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Door Contact</td>
<td>1078D (DPDT) - 1&quot; diameter</td>
<td></td>
<td>OT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>concealed</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Notes: Door shall be monitored on schedule. Custom signage will be installed indicating the door is armed and to contact Wayne State University Police before opening.

Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

Factory notch door bottom rain drip for frame stops.

**Set: 11.0**

**Doors: 2290.20**

<table>
<thead>
<tr>
<th>Description</th>
<th>Model/Spec</th>
<th>Finish 1</th>
<th>Finish 2</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Continuous Hinge</td>
<td>CFM-HD1</td>
<td>PE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Storeroom Lock</td>
<td>ML2057 NSA LC</td>
<td>626</td>
<td>RU</td>
<td></td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key</td>
<td>626</td>
<td>BE</td>
<td></td>
</tr>
</tbody>
</table>
NOTES:

Door shall be monitored on schedule. Custom signage will be installed indicating the door is armed and to contact Wayne State University Police before opening.

Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

**Set: 12.0**

 Doors: 1290.01C

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Model Number</th>
<th>Supplier</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Surf Overhead Stop</td>
<td>9-X36</td>
<td>RF</td>
<td></td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC8220 top jamb x mounting plate to suit application</td>
<td>RU</td>
<td></td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>1 Threshold</td>
<td>279x292AFGPK x MSES25SS</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Weatherstrip</td>
<td>2891APK x TKSP8 - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Door Bottom</td>
<td>216BDCFG x TKSP8</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Door Contact</td>
<td>1078D (DPDT) - 1&quot; diameter concealed</td>
<td>OT</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Door shall be monitored on schedule. Custom signage will be installed indicating the door is armed and to contact Wayne State University Police before opening.

Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.
Notes: Door normally closed and locked. Key override outside retracts latch bolt of exit device. Doors may be unlocked (latch retracted electronically) upon schedule as determined in access control system or by keyed dogging inside. Exit device equipped with signal switch in push rail to act as shunt for door monitoring upon egress. Vestibule side ADA actuator switch will not cycle automatic operator unless latch bolt is retracted (may utilize latch bolt monitor switch for this function). Automatic operator actuator switches shall not cycle automatic operator when door is locked.

**Set: 13.0**

<table>
<thead>
<tr>
<th>Doors: 1290.01D</th>
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</thead>
<tbody>
<tr>
<td>2 Continuous Hinge</td>
</tr>
<tr>
<td>1 Mullion</td>
</tr>
<tr>
<td>2 Exit Device (exit only)</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
</tr>
<tr>
<td>2 Pull</td>
</tr>
<tr>
<td>2 Surf Overhead Stop</td>
</tr>
<tr>
<td>2 Drop Plate</td>
</tr>
<tr>
<td>2 Surface Closer</td>
</tr>
<tr>
<td>2 Door Contact</td>
</tr>
<tr>
<td>2 Electric Power Transfer</td>
</tr>
<tr>
<td>1 Power Supply</td>
</tr>
</tbody>
</table>

Notes: Door normally closed and locked. Doors may be unlocked (latch retracted electronically) upon schedule as determined in access control system or by keyed dogging inside. Exit device equipped with signal switch in push rail to act as shunt for door monitoring upon egress. Vestibule side ADA actuator switch will not cycle automatic operator unless latch bolt is retracted (may utilize latch bolt monitor switch for this function). Automatic operator actuator switches shall not cycle automatic operator when door is locked.

**Set: 14.0**

<table>
<thead>
<tr>
<th>Doors: 1340.03</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Hinge (heavy weight)</td>
</tr>
<tr>
<td>1 Rim Exit Device</td>
</tr>
<tr>
<td>1 Rim Cylinder</td>
</tr>
<tr>
<td>1 Surface Closer</td>
</tr>
<tr>
<td>1 Kick Plate</td>
</tr>
</tbody>
</table>

DOOR HARDWARE   087100 - 29
1 Wall Stop 406 US32D RO
1 Smoke / Sound Seal S88D - head and jambs PE
1 Door Contact 1078D (DPDT) - 1" diameter OT concealed
1 Electric Power Transfer EPT10 SP28 VD ¬
1 Power Supply PS902 VD ¬
1 Card Reader Provided by Security Contractor 00

Notes: Door normally closed and locked. Valid use of card reader temporarily unlocks lever trim for access. Push rail equipped with built-in signal switch to be wired for request to exit. Free egress always permitted.

Set: 15.0

Doors: 0302

6 Hinge (heavy weight) T4A3786 US26D MK
1 Mullion 12-L980 PC SA
1 Rim Fire Exit Device, Storeroom 12 LC 43 8804 ETL US32D SA
1 Rim Fire Exit Device, Exit Only 12 43 8810 EO US32D SA
1 Mort. Cylinder - match Owner's existing Best key system 626 BE
1 Rim Cylinder - match Owner's existing Best key system 626 BE
2 Surface Closer DC6210 A3 689 RU
2 Kick Plate K1050 10" high BEV CSK US32D RO
2 Wall Stop 406 US32D RO
1 Smoke / Sound Seal S88D - head and jambs PE
1 Meeting Edge Seal S772C x height of door PE

Notes: ** Provide hinge sizing as appropriate at 180 degree opening assemblies.

Key outside retracts latch bolt. Outside lever rigid. Free egress always permitted.

Set: 15.1

Doors: 1190.19B

6 Hinge, Full Mortise, Hvy Wt T4A3786 US10B MK
1 Mullion 12-L980 PC SA
1 Rim Fire Exit Device, Storeroom 12 LC 43 8804 ETL US10B SA
1 Rim Fire Exit Device, Exit Only 12 43 8810 EO US10B SA
1 Mort. Cylinder - match Owner's existing Best key system 613 BE
1 Rim Cylinder - match Owner's existing Best key system 613 BE
2 Surface Closer DC6210 A3 690 RU
2 Kick Plate K1050 10" high BEV CSK US10B RO
2 Wall Stop 406 US10BE RO
1 Smoke / Sound Seal S88D - head and jambs PE
1 Meeting Edge Seal S772C x height of door PE

Notes: ** Provide hinge sizing as appropriate at 180 degree opening assemblies.

Key outside retracts latch bolt. Outside lever rigid.
Free egress always permitted.

Set: 16.0

Doors: 0290.20A, 0301, 2290.16

6 Hinge (heavy weight) T4A3786 US26D MK
1 Mullion 12-L980 PC SA
1 Rim Fire Exit Device, Storeroom 12 LC 43 8804 ETL US32D SA
1 Rim Fire Exit Device, Exit Only 12 43 8810 EO US32D SA
1 Mort. Cylinder - match Owner's existing Best key system 626 BE
1 Rim Cylinder - match Owner's existing Best key system 626 BE
2 Surface Closer DC6210 A4 689 RU
2 Kick Plate K1050 10" high BEV CSK US32D RO
1 Smoke / Sound Seal S88D - head and jambs PE
1 Meeting Edge Seal S772C x height of door PE

Notes: Key outside retracts latch bolt. Outside lever rigid.
Free egress always permitted.

Set: 17.0
3 Hinge, Full Mortise, Hvy Wt  T4A3786  US10B  MK
1 Rim Fire Exit Device, Storeroom  12 LC 43 8804 ETL  US10B  SA
1 Rim Cylinder  - match Owner's existing Best key system  613  BE
1 Surface Closer  DC6210 A4  690  RU
1 Kick Plate  K1050 10" high BEV CSK  US10B  RO
1 Smoke / Sound Seal  S88D - head and jambs  PE

Notes: Key outside retracts latch bolt. Outside lever rigid. Free egress always permitted.

**Set: 17.1**

Doors: 1324

4 Hinge (heavy weight)  T4A3786  US26D  MK
1 Rim Fire Exit Device, Storeroom  12 LC 43 8804 ETL  US32D  SA
1 Rim Cylinder  - match Owner's existing Best key system  626  BE
1 Surface Closer  DC6210 A4  689  RU
1 Kick Plate  K1050 10" high BEV CSK  US32D  RO
1 Smoke / Sound Seal  S88D - head and jambs  PE
3 Silencer  608 / 609  RO

Notes: Key outside retracts latch bolt. Outside lever rigid. Free egress always permitted.

**Set: 18.0**

8 Hinge (heavy weight)  T4A3786  US26D  MK
1 Surface Vert Rod Exit  LC 43 NB8706 ETL  US32D  SA
1 Surface Vert Rod Exit, Exit Only  43 NB8710 EO  US32D  SA
1 Rim Cylinder  - match Owner's existing Best key system  626  BE
2 Surface Closer  DC6210 A3  689  RU
2 Kick Plate  K1050 10" high BEV CSK  US32D  RO
2 Wall Stop  406  US32D  RO
1 Smoke / Sound Seal  S88D - head and jambs  PE
1 Meeting Edge Seal  S772C x height of door  PE
Notes: ** Provide hinges to suit 180 degree opening.

Key outside unlocks lever trim, lever retracts latch, lever relocks when key is removed. Exit device equipped with keyed cylinder dogging to control push/pull operation. Free egress always permitted.

<table>
<thead>
<tr>
<th>Set: 19.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doors: 1330</td>
</tr>
<tr>
<td><strong>8</strong> Hinge (heavy weight)</td>
</tr>
<tr>
<td><strong>2</strong> Surface Vert Rod Exit, Exit Only</td>
</tr>
<tr>
<td><strong>2</strong> Surface Closer</td>
</tr>
<tr>
<td><strong>2</strong> Kick Plate</td>
</tr>
<tr>
<td><strong>2</strong> Wall Stop</td>
</tr>
<tr>
<td><strong>1</strong> Smoke / Sound Seal</td>
</tr>
<tr>
<td><strong>1</strong> Meeting Edge Seal</td>
</tr>
</tbody>
</table>

Notes: Exit only. No outside trim. Free egress always permitted.

<table>
<thead>
<tr>
<th>Set: 20.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doors: 1200.1B</td>
</tr>
<tr>
<td><strong>8</strong> Hinge (heavy weight)</td>
</tr>
<tr>
<td><strong>2</strong> Exit Device (classroom)</td>
</tr>
<tr>
<td><strong>2</strong> Mort. Cylinder</td>
</tr>
<tr>
<td><strong>2</strong> Surface Closer</td>
</tr>
<tr>
<td><strong>2</strong> Kick Plate</td>
</tr>
<tr>
<td><strong>2</strong> Wall Stop</td>
</tr>
<tr>
<td><strong>1</strong> Sound / Smoke Seal</td>
</tr>
<tr>
<td><strong>1</strong> Meeting Edge Seal</td>
</tr>
</tbody>
</table>

Notes: Key outside locks or unlocks lever trim. Free egress always permitted.

<table>
<thead>
<tr>
<th>Set: 21.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doors: 1190.19C</td>
</tr>
</tbody>
</table>
### Bulletin 012 - BP4_2021-08-13

**Gateway Theater Complex**

**HAA Project No. 2016034.00**

**WSU Project No. 189-178578**

13 August 2021

<table>
<thead>
<tr>
<th>Description</th>
<th>Model Nr</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Hinge, Full Mortise, Hvy Wt</td>
<td>T4A3786</td>
<td>US10B MK</td>
</tr>
<tr>
<td>2 Concealed Vert Rod Exit, Classroom</td>
<td>LC NB 43 WD8613 ETL</td>
<td>US10B SA</td>
</tr>
<tr>
<td>2 Mort. Cylinder</td>
<td></td>
<td>- match Owner's existing Best key system</td>
</tr>
<tr>
<td>2 Mounting Bracket</td>
<td>2601AB / 2601C</td>
<td>US28 RO</td>
</tr>
<tr>
<td>2 Surface Closer</td>
<td>DC6210 A4</td>
<td>690 RU</td>
</tr>
<tr>
<td>2 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US10B RO</td>
</tr>
<tr>
<td>1 Sound / Smoke Seal</td>
<td>S773D - head and jambs</td>
<td>PE</td>
</tr>
<tr>
<td>2 Conc. Auto. Door Bottom</td>
<td>420APKL</td>
<td>PE</td>
</tr>
<tr>
<td>1 Meeting Edge Seal</td>
<td>S772C x height of door</td>
<td>PE</td>
</tr>
</tbody>
</table>

**Notes:** **Mounting brackets 2601AB/C for mounting of door closer around adjustable sound seal.**

Key outside locks or unlocks lever trim. Free egress always permitted.

### Set: 22.0

**Doors:** 1200

- 8 Hinge (heavy weight) T4A3786 US26D MK
- 2 Exit Device (classroom) LC 43 NB8713 ETL US32D SA
- 2 Mort. Cylinder - match Owner's existing Best key system 626 BE
- 2 Surface Closer DC6210 A4 689 RU
- 2 Kick Plate K1050 10" high BEV CSK US32D RO
- 2 Door Stop & Holder 490 US26D RO
- 1 Sound / Smoke Seal S773D - head and jambs PE
- 1 Meeting Edge Seal S772C x height of door PE

**Notes:** **Provide hinges to suit 180 degree opening.**

Key outside locks or unlocks lever trim. Free egress always permitted.

### Set: 23.0

**Doors:** 1200.1A

- 4 Hinge (heavy weight) T4A3786 US26D MK
- 1 Exit Device (classroom) LC 43 8813 ETL US32D SA
- 1 Mort. Cylinder - match Owner's existing Best key system 626 BE
### Set: 24.0

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Model/Part Number</th>
<th>Finish/Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Conc Overhead Stop</td>
<td>1</td>
<td>X36</td>
<td>RF</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td></td>
<td>DC6220</td>
<td>RU</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td></td>
<td>K1050</td>
<td>US2D RO</td>
</tr>
<tr>
<td>1 Threshold</td>
<td></td>
<td>151A MSES25SS</td>
<td>PE</td>
</tr>
<tr>
<td>1 Adjustable Sound Seal</td>
<td></td>
<td>379CS TKSP</td>
<td>PE</td>
</tr>
<tr>
<td>1 Auto. Door Bottom</td>
<td></td>
<td>STC411APK</td>
<td>PE</td>
</tr>
</tbody>
</table>

**Notes:** Key outside locks or unlocks lever trim. Free egress always permitted.

### Set: 25.0

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Model/Part Number</th>
<th>Finish/Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Hinge (heavy weight)</td>
<td>3</td>
<td>T4A3786</td>
<td>US26D MK</td>
</tr>
<tr>
<td>1 Exit Device (classroom)</td>
<td>1</td>
<td>LC 43 8813 ETL</td>
<td>US32D SA</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>1</td>
<td>- match Owner's existing Best key system</td>
<td>626 BE</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>1</td>
<td>DC6210 A3</td>
<td>RU</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>1</td>
<td>K1050</td>
<td>US2D RO</td>
</tr>
<tr>
<td>1 Wall Stop</td>
<td>1</td>
<td>406</td>
<td>US2D RO</td>
</tr>
<tr>
<td>1 Threshold</td>
<td>1</td>
<td>151A MSES25SS</td>
<td>PE</td>
</tr>
<tr>
<td>1 Adjustable Sound Seal</td>
<td>1</td>
<td>379CS TKSP</td>
<td>PE</td>
</tr>
<tr>
<td>1 Auto. Door Bottom</td>
<td>1</td>
<td>STC411APK</td>
<td>PE</td>
</tr>
</tbody>
</table>

**Notes:** Key outside locks or unlocks lever trim. Free egress always permitted.
1 Threshold
151D MSES25SS (3" x 1/4") - position directly under door bottom
PE

1 Adjustable Sound Seal
379DS TKSP - head and jambs
PE

1 Auto. Door Bottom
STC411APK x width of door
PE

Notes: Key outside locks or unlocks lever trim. Free egress always permitted.

Set: 26.0

Doors: 1290.05B, 1290.15A

4 Hinge, Full Mortise, Hvy Wt
T4A3786
BSP MK

1 Rim Exit Device, Classroom
LC 43 8813 ETL
BSP SA

1 Mort. Cylinder
- match Owner's existing Best key system
BL BE

1 Surface Closer
DC6210 A4
BSP RU

1 Kick Plate
K1050 10" high CSK BEV
BSP RO

1 Sound / Smoke Seal
S773D - head and jambs
PE

Notes: Key outside locks or unlocks lever trim. Free egress always permitted.

Set: 27.0

Doors: 1290.14A

4 Hinge (heavy weight)
T4A3786
US26D MK

1 Mortise Exit Device, Classroom
LC 43 8913 ETL
US32D SA

1 Mort. Cylinder
- match Owner's existing Best key system
626 BE

1 Conc Overhead Stop
2-X36
652 RF

1 Surface Closer
DC6220 top jamb x mounting plate to suit application
689 RU

1 Kick Plate
K1050 10" high BEV CSK
US32D RO

1 Threshold
151A MSES25SS (3" x 1/4") - position directly under door bottom
PE

1 Adjustable Sound Seal
379CS TKSP - head and jambs
PE

1 Auto. Door Bottom
STC411APK x width of door
PE

Notes: Key outside locks or unlocks lever trim. Free egress always permitted.
### Set: 27.1

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Hinge, Full Mortise, Hvy Wt</td>
<td></td>
<td>T4A3786</td>
</tr>
<tr>
<td>1 Mortise Exit Device, Classroom</td>
<td></td>
<td>LC 43 8913 ETL</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td></td>
<td>- match Owner's existing Best key system</td>
</tr>
<tr>
<td>1 Conc Overhead Stop</td>
<td></td>
<td>2-X36</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td></td>
<td>DC6220 top jamb x mounting plate to suit application</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td></td>
<td>K1050 10&quot; high CSK BEV</td>
</tr>
<tr>
<td>1 Threshold</td>
<td></td>
<td>151BSP MSES25SS (3&quot; x 1/4&quot;) - position directly under door bottom</td>
</tr>
<tr>
<td>1 Adjustable Sound Seal</td>
<td></td>
<td>379BSPS TKSP - head and jambs</td>
</tr>
<tr>
<td>1 Auto. Door Bottom</td>
<td></td>
<td>STC411APK x width of door</td>
</tr>
</tbody>
</table>

Notes: Key outside locks or unlocks lever trim. Free egress always permitted.

### Set: 28.0

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Hinge, Full Mortise, Hvy Wt</td>
<td></td>
<td>T4A3786</td>
</tr>
<tr>
<td>1 Rim Exit Device, Classroom</td>
<td></td>
<td>12 LC 43 8813 ETL</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td></td>
<td>- match Owner's existing Best key system</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td></td>
<td>DC6210 A4</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td></td>
<td>K1050 10&quot; high CSK BEV</td>
</tr>
<tr>
<td>1 Sound / Smoke Seal</td>
<td></td>
<td>S773D - head and jambs</td>
</tr>
</tbody>
</table>

Notes: Key outside locks or unlocks lever trim. Free egress always permitted.

### Set: 29.0

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Hinge, Full Mortise, Hvy Wt</td>
<td></td>
<td>T4A3786</td>
</tr>
<tr>
<td>1 Mortise Exit Device, Passage</td>
<td></td>
<td>43 8915 ETL</td>
</tr>
<tr>
<td>1 Mounting Bracket</td>
<td></td>
<td>2601AB / 2601C</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td></td>
<td>DC6210 A3</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td></td>
<td>K1050 10&quot; high CSK BEV</td>
</tr>
</tbody>
</table>
1 Wall Stop &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; 402 &nbsp; &nbsp; &nbsp; BSP &nbsp; &nbsp; &nbsp; RO &nbsp; 
1 Threshold &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; 151BSP MSES25SS (3" x 1/4") - position directly under door bottom &nbsp; &nbsp; &nbsp; PE &nbsp; 
1 Adjustable Sound Seal &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; 379BSPS TKSP - head and jambs &nbsp; &nbsp; &nbsp; PE &nbsp; 
1 Auto. Door Bottom &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; &nbsp; STC411APK x width of door &nbsp; &nbsp; &nbsp; PE &nbsp; 

Notes: ** Install mounting bracket 2601AB/C for mounting of door closer to avoid conflict with adjustable sound seal.

**Set: 30.0**

Doors: 0290.19, 1290.19B, 2290.05, 2290.15, 2290.19B

| 3 Hinge (heavy weight) | T4A3786 | US26D | MK |
| 1 Fire Exit Device (passage) | 12 43 8815 ETL | US32D | SA |
| 1 Surface Closer | DC6200 - pull side mount | 689 | RU |
| 1 Kick Plate | K1050 10" high BEV CSK | US32D | RO |
| 1 Wall Stop | 406 | US32D | RO |
| 1 Sound / Smoke Seal | S773D - head and jambs | PE |

Notes: Passage lever trim. Free egress always permitted.

**Set: 31.0**

Doors: 0240.01

| 6 Hinge (heavy weight) | T4A3786 | US26D | MK |
| 2 Concealed Vert Rod Exit | 12 LC NB 43 WD8606 ETL | US32D | SA |
| 2 Mort. Cylinder | - match Owner's existing Best key system | 626 | BE |
| 2 Rim Cylinder | - match Owner's existing Best key system | 626 | BE |
| 2 Surface Closer | DC6210 A4 | 689 | RU |
| 2 Kick Plate | K1050 10" high BEV CSK | US32D | RO |
| 1 Threshold | 151A MSES25SS (3" x 1/4") - position directly under door bottom | PE |
| 1 Adjustable Sound Seal | 379CS TKSP - head and jambs | PE |
| 2 Auto. Door Bottom | STC411APK x width of door | PE |
| 1 Adjustable Astragal Set | 351C/CS x TKSP x height of doors | PE |

Notes: Key outside unlocks lever trim, lever retracts latch, lever relocks when key is removed. Exit device equipped with keyed cylinder dogging to control push/pull operation.
Free egress always permitted.

**Set: 32.0**

<table>
<thead>
<tr>
<th>Item</th>
<th>Door Details</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Hinge (heavy weight)</td>
<td>T4A3786 US26D MK</td>
<td></td>
</tr>
<tr>
<td>2 Surface Vert Rod Exit, Passage</td>
<td>43 NB8715 ETL US32D SA</td>
<td></td>
</tr>
<tr>
<td>2 Conc Overhead Stop</td>
<td>1-X36 652 RF</td>
<td></td>
</tr>
<tr>
<td>2 Surface Closer</td>
<td>DC6220 top jamb x mounting plate to suit application 689 RU</td>
<td></td>
</tr>
<tr>
<td>2 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK US32D RO</td>
<td></td>
</tr>
<tr>
<td>1 Threshold</td>
<td>151A MSES25SS (3&quot; x 1/4&quot;) - position directly under door bottom PE</td>
<td></td>
</tr>
<tr>
<td>1 Adjustable Sound Seal</td>
<td>379CS TKSP - head and jambs PE</td>
<td></td>
</tr>
<tr>
<td>2 Auto. Door Bottom</td>
<td>STC411APK x width of door PE</td>
<td></td>
</tr>
<tr>
<td>1 Adjustable Astragal Set</td>
<td>351C/CS x TKSP x height of doors PE</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ** Provide stop arm closer on one leaf for Door 1390.02A.

Passage lever trim. Free egress always permitted.

**Set: 32.1**

<table>
<thead>
<tr>
<th>Item</th>
<th>Door Details</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Hinge, Full Mortise, Hvy Wt</td>
<td>T4A3786 BSP MK</td>
<td></td>
</tr>
<tr>
<td>2 Surface Vert Rod Exit, Passage</td>
<td>43 NB8715 ETL BSP SA</td>
<td></td>
</tr>
<tr>
<td>2 Conc Overhead Stop</td>
<td>1-X36 BSP RF</td>
<td></td>
</tr>
<tr>
<td>2 Surface Closer</td>
<td>DC6220 top jamb x mounting plate to suit application BSP RU</td>
<td></td>
</tr>
<tr>
<td>2 Kick Plate</td>
<td>K1050 10&quot; high CSK BEV BSP RO</td>
<td></td>
</tr>
<tr>
<td>1 Threshold</td>
<td>151BSP MSES25SS (3&quot; x 1/4&quot;) - position directly under door bottom PE</td>
<td></td>
</tr>
<tr>
<td>1 Adjustable Sound Seal</td>
<td>379BSPS TKSP - head and jambs PE</td>
<td></td>
</tr>
<tr>
<td>2 Auto. Door Bottom</td>
<td>STC411APK x width of door PE</td>
<td></td>
</tr>
<tr>
<td>2 Astragal</td>
<td>351BSP/BSPS x TKSP x height of doors PE</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ** Provide stop arm closer on one leaf for Door 1390.02A.

Passage lever trim. Free egress always permitted.
Set: 33.0

Doors: 2235

2 Hinge (heavy weight)  T4A3786  US26D  MK  
1 Fail Secure Lock  ML20906-SEC NSA M92 LC  626  RU  
1 Mort. Cylinder  - match Owner's existing Best key system  626  BE  
1 Surface Closer  DC6200 - pull side mount  689  RU  
1 Kick Plate  K1050 10" high BEV CSK  US32D  RO  
1 Wall Stop  406  US32D  RO  
3 Silencer  608 / 609  RO  
1 Door Contact  1078D (DPDT) - 1" diameter concealed  OT  
1 Electric Power Transfer  CEPT-10  SU  
1 Power Supply  BPS-24 (amp capacity as required)  SU  
1 Card Reader  - Provided by Security Contractor  00

Notes: Door normally closed and locked. Key override outside retracts latch bolt. Valid use of card reader outside temporarily unlocks outside lever for access. Inside lever function equipped with signal switch for request to exit alarm shunt (REX). Free egress always permitted.

Set: 34.0

Doors: 1338, 2230

2 Hinge (heavy weight)  T4A3786  US26D  MK  
1 Fail Secure Lock  ML20906-SEC NSA M92 LC  626  RU  
1 Mort. Cylinder  - match Owner's existing Best key system  626  BE  
1 Surface Closer  DC6210 A3  689  RU  
1 Kick Plate  K1050 10" high BEV CSK  US32D  RO  
1 Wall Stop  406  US32D  RO  
1 Smoke / Sound Seal  S88D - head and jambs  PE  
1 Door Contact  1078D (DPDT) - 1" diameter concealed  OT  
1 Electric Power Transfer  CEPT-10  SU  
1 Power Supply  BPS-24 (amp capacity as required)  SU  
1 Card Reader  - Provided by Security Contractor  00
Notes: Door normally closed and locked. Key override outside retracts latch bolt. Valid use of card reader outside temporarily unlocks outside lever for access. Inside lever function equipped with signal switch for request to exit alarm shunt (REX). Free egress always permitted.

**Set: 35.0**

Doors: 2223

- 3 Hinge (heavy weight) T4A3786 US26D MK
- 1 Fail Secure Lock ML20906-SEC NSA M92 LC 626 RU
- 1 Mort. Cylinder - match Owner's existing Best key system 626 BE
- 1 Surface Closer DC6220 top jamb x mounting plate to suit application 689 RU
- 1 Kick Plate K1050 10" high BEV CSK US32D RO
- 1 Wall Stop 406 US32D RO
- 1 Threshold 151A MSES25SS (3" x 1/4") - position directly under door bottom PE
- 1 Adjustable Sound Seal 379CS TKSP - head and jambs PE
- 1 Auto. Door Bottom STC411APK x width of door PE
- 3 Silencer 608 / 609 RO
- 1 Door Contact 1078D (DPDT) - 1" diameter concealed OT
- 1 Electric Power Transfer CEPT-10 SU
- 1 Power Supply BPS-24 (amp capacity as required) SU
- 1 Card Reader - Provided by Security Contractor 00

Notes: Door normally closed and locked. Key override outside retracts latch bolt. Valid use of card reader outside temporarily unlocks outside lever for access. Inside lever function equipped with signal switch for request to exit alarm shunt (REX). Free egress always permitted.

**Set: 36.0**

Doors: 1221, 1313.02, 1329.01, 1335, 2231

- 4 Hinge (heavy weight) T4A3786 US26D MK
- 1 Fail Secure Lock ML20906-SEC NSA M92 LC 626 RU
- 1 Mort. Cylinder - match Owner's existing Best key system 626 BE
- 1 Surface Closer DC6210 A4 689 RU
1 Kick Plate                      | K1050 10" high BEV CSK | US32D | RO 
1 Smoke / Sound Seal           | S88D - head and jambs  | PE    | 
1 Door Contact                  | 1078D (DPDT) - 1" diameter concealed | OT    | 
1 Electric Power Transfer       | CEPT-10               | SU    | ♦ 
1 Power Supply                  | BPS-24 (amp capacity as required) | SU    | ♦ 
1 Card Reader                   | - Provided by Security Contractor | 00    | 

Notes: Door normally closed and locked. Key override outside retracts latch bolt. Valid use of card reader outside temporarily unlocks outside lever for access. Inside lever function equipped with signal switch for request to exit alarm shunt (REX). Free egress always permitted.

**Set: 36.1**

Doors: 1222

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Hinge, Full Mortise, Hvy Wt</td>
<td>T4A3786 BSP MK</td>
</tr>
<tr>
<td>1 Fail Secure Lock</td>
<td>ML20906-SEC NSA M92 LC SU ♦</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6210 A4 BSP RU</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high CSK BEV BSP RO</td>
</tr>
<tr>
<td>3 Silencer</td>
<td>608 / 609 RO</td>
</tr>
<tr>
<td>1 Door Contact</td>
<td>1078D (DPDT) - 1&quot; diameter concealed OT</td>
</tr>
<tr>
<td>1 Electric Power Transfer</td>
<td>CEPT-10 SU ♦</td>
</tr>
<tr>
<td>1 Power Supply</td>
<td>BPS-24 (amp capacity as required) SU ♦</td>
</tr>
<tr>
<td>1 Card Reader</td>
<td>- Provided by Security Contractor 00</td>
</tr>
</tbody>
</table>

Notes: Door normally closed and locked. Key override outside retracts latch bolt. Valid use of card reader outside temporarily unlocks outside lever for access. Inside lever function equipped with signal switch for request to exit alarm shunt (REX). Free egress always permitted.

**Set: 37.0**

Doors: 1326

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Hinge (heavy weight)</td>
<td>T4A3786 US26D MK</td>
</tr>
<tr>
<td>1 Flush Bolt</td>
<td>555 / 557 US26D RO</td>
</tr>
<tr>
<td>Item Description</td>
<td>Part Name</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Dust Proof Strike</td>
<td>570</td>
</tr>
<tr>
<td>Top Flush Bolt</td>
<td>555-24</td>
</tr>
<tr>
<td>Fail Secure Lock</td>
<td>ML20906-SEC NSA M92 LC</td>
</tr>
<tr>
<td>Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
</tr>
<tr>
<td>Surf Overhead Stop</td>
<td>9-X36</td>
</tr>
<tr>
<td>Surface Closer</td>
<td>DC6210 A4</td>
</tr>
<tr>
<td>Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
</tr>
<tr>
<td>Silencer</td>
<td>608 / 609</td>
</tr>
<tr>
<td>Door Contact</td>
<td>1078D (DPDT) - 1&quot; diameter concealed</td>
</tr>
<tr>
<td>Electric Power Transfer</td>
<td>CEPT-10</td>
</tr>
<tr>
<td>Power Supply</td>
<td>BPS-24 (amp capacity as required)</td>
</tr>
<tr>
<td>Card Reader</td>
<td>- Provided by Security Contractor</td>
</tr>
</tbody>
</table>

Notes: Door normally closed and locked. Key override outside retracts latch bolt. Valid use of card reader outside temporarily unlocks outside lever for access. Inside lever function equipped with signal switch for request to exit alarm shunt (REX). Free egress always permitted.

**Set: 38.0**

Doors: 1328

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Part Name</th>
<th>Code</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hinge (heavy weight)</td>
<td>T4A3786</td>
<td>US26D MK</td>
<td></td>
</tr>
<tr>
<td>Flush Bolt</td>
<td>555 / 557</td>
<td>US26D RO</td>
<td></td>
</tr>
<tr>
<td>Dust Proof Strike</td>
<td>570</td>
<td>US26D RO</td>
<td></td>
</tr>
<tr>
<td>Top Flush Bolt</td>
<td>555-24</td>
<td>US26D RO</td>
<td></td>
</tr>
<tr>
<td>Fail Secure Lock</td>
<td>ML20906-SEC NSA M92 LC</td>
<td>626 RU</td>
<td></td>
</tr>
<tr>
<td>Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626 BE</td>
<td></td>
</tr>
<tr>
<td>Conc Overhead Stop</td>
<td>1-X36</td>
<td>652 RF</td>
<td></td>
</tr>
<tr>
<td>Surface Closer</td>
<td>DC6200 - pull side mount</td>
<td>689 RU</td>
<td></td>
</tr>
<tr>
<td>Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D RO</td>
<td></td>
</tr>
<tr>
<td>Wall Stop</td>
<td>406</td>
<td>US32D RO</td>
<td></td>
</tr>
<tr>
<td>Silencer</td>
<td>608 / 609</td>
<td>RO</td>
<td></td>
</tr>
<tr>
<td>Door Contact</td>
<td>1078D (DPDT) - 1&quot; diameter concealed</td>
<td>OT</td>
<td></td>
</tr>
<tr>
<td>Electric Power Transfer</td>
<td>CEPT-10</td>
<td>SU</td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td>BPS-24 (amp capacity as required)</td>
<td>SU</td>
<td></td>
</tr>
</tbody>
</table>
1 Card Reader - Provided by Security Contractor

Notes: Door normally closed and locked. Key override outside retracts latch bolt. Valid use of card reader outside temporarily unlocks outside lever for access. Inside lever function equipped with signal switch for request to exit alarm shunt (REX). Free egress always permitted.

**Set: 39.0**

**Doors: 1118**

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Number</th>
<th>Finish</th>
<th>Trim</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US10B</td>
<td>MK</td>
</tr>
<tr>
<td>1 Dust Proof Strike</td>
<td>570</td>
<td>US10B</td>
<td>RO</td>
</tr>
<tr>
<td>1 Flush Bolt</td>
<td>555 / 557</td>
<td>US10B</td>
<td>RO</td>
</tr>
<tr>
<td>1 Storeroom Lock</td>
<td>ML2057 NSA LC</td>
<td>613</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>613</td>
<td>BE</td>
</tr>
<tr>
<td>2 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US10B</td>
<td>RO</td>
</tr>
<tr>
<td>2 Door Stop &amp; Holder</td>
<td>490</td>
<td>US26D</td>
<td>RO</td>
</tr>
<tr>
<td>2 Silencer</td>
<td>608 / 609</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

**Set: 40.0**

**Doors: 1102**

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Number</th>
<th>Finish</th>
<th>Trim</th>
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</thead>
<tbody>
<tr>
<td>6 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US10B</td>
<td>MK</td>
</tr>
<tr>
<td>1 Comb. Flush Bolt Set</td>
<td>2845 (HM) / 2945 (WD)</td>
<td>US10B</td>
<td>RO</td>
</tr>
<tr>
<td>1 Dust Proof Strike</td>
<td>570</td>
<td>US10B</td>
<td>RO</td>
</tr>
<tr>
<td>1 Storeroom Lock</td>
<td>ML2057 NSA LC</td>
<td>613</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>613</td>
<td>BE</td>
</tr>
<tr>
<td>1 Coordinator</td>
<td>2672</td>
<td>US28</td>
<td>RO</td>
</tr>
<tr>
<td>1 Filler Bar</td>
<td>FB-1 / FB-2</td>
<td>US28</td>
<td>RO</td>
</tr>
<tr>
<td>2 Mounting Bracket</td>
<td>2601AB / 2601C</td>
<td>US28</td>
<td>RO</td>
</tr>
<tr>
<td>2 Surface Closer</td>
<td>DC6210 A4</td>
<td>690</td>
<td>RU</td>
</tr>
<tr>
<td>2 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US10B</td>
<td>RO</td>
</tr>
<tr>
<td>1 Smoke / Sound Seal</td>
<td>S88D - head and jambs</td>
<td></td>
<td>PE</td>
</tr>
<tr>
<td>1 Meeting Edge Seal</td>
<td>S772C x height of door</td>
<td></td>
<td>PE</td>
</tr>
</tbody>
</table>

DOOR HARDWARE 087100 - 44
Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

### Set: 41.0

**Doors:** 1217, 2325.01, 2325.02

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Description</th>
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<tr>
<td>8 Hinge, Full Mortise</td>
<td></td>
<td>TA2714 US26D MK</td>
</tr>
<tr>
<td>1 Flush Bolt</td>
<td></td>
<td>555 / 557 US26D RO</td>
</tr>
<tr>
<td>1 Dust Proof Strike</td>
<td></td>
<td>570 US26D RO</td>
</tr>
<tr>
<td>1 Storeroom Lock</td>
<td></td>
<td>ML2057 NSA LC RO</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td></td>
<td>- match Owner's existing Best key system</td>
</tr>
<tr>
<td>1 Surf Overhead Stop</td>
<td></td>
<td>9-X36 652 RF</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td></td>
<td>DC6210 A4 689 RU</td>
</tr>
<tr>
<td>2 Kick Plate</td>
<td></td>
<td>K1050 10'' high BEV CSK US32D RO</td>
</tr>
<tr>
<td>1 Smoke / Sound Seal</td>
<td></td>
<td>S88D - head and jambs PE</td>
</tr>
<tr>
<td>1 Meeting Edge Seal</td>
<td></td>
<td>S772C x height of door PE</td>
</tr>
</tbody>
</table>

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

### Set: 42.0

**Doors:** 1105, 1123

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Hinge, Full Mortise</td>
<td></td>
<td>TA2714 US10B MK</td>
</tr>
<tr>
<td>1 Storeroom Lock</td>
<td></td>
<td>ML2057 NSA LC RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td></td>
<td>- match Owner's existing Best key system</td>
</tr>
<tr>
<td>1 Surf Overhead Hold Open</td>
<td></td>
<td>10-X26 613 RF</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td></td>
<td>K1050 10'' high BEV CSK US10B RO</td>
</tr>
<tr>
<td>3 Silencer</td>
<td></td>
<td>608 / 609 RO</td>
</tr>
</tbody>
</table>

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

### Set: 43.0

**Doors:** 1225.01, 1225.02, 2290.06

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DOOR HARDWARE 087100 - 46

Set: 43.1

Doors: 1116

3 Hinge, Full Mortise  TA2714  US26D  MK
1 Storeroom Lock  ML2057 NSA LC  626  RU
1 Mort. Cylinder  - match Owner's existing Best key system  626  BE
1 Surface Closer  DC6200 - pull side mount  689  RU
1 Kick Plate  K1050 10" high BEV CSK  US32D  RO
1 Wall Stop  406  US32D  RO
1 Threshold  151A MSES25SS (3" x 1/4") - position directly under door bottom  PE
1 Adjustable Sound Seal  379CS TKSP - head and jambs  PE
1 Auto. Door Bottom  STC411APK x width of door  PE
3 Silencer  608 / 609  RO

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

Set: 44.0

Doors: 1223, 1233, 1322

3 Hinge, Full Mortise  TA2714  US26D  MK
## Gateway Theater Complex
### Bulletin 012 - BP4_2021-08-13
Date: 13 August 2021

### Storeroom Lock
- **ML2057 NSA LC**
- **ML2057 NSA LC**

### Mort. Cylinder
- **- match Owner's existing Best key system**

### Surface Closer
- **DC6210 A4**

### Kick Plate
- **K1050 10" high BEV CSK**

### Silencer
- **608 / 609**

**Notes:**
- Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.
- Set: **45.0**
- Doors: **1203, 2290.08**

### Hinge, Full Mortise
- **TA2714**

### Storeroom Lock
- **ML2057 NSA LC**

### Mort. Cylinder
- **- match Owner's existing Best key system**

### Surface Closer
- **DC6200 - pull side mount**

### Kick Plate
- **K1050 10" high BEV CSK**

### Wall Stop
- **406**

### Door Stop & Holder
- **490**

### Silencer
- **608 / 609**

**Notes:**
- Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.
- Set: **46.0**
- Doors: **1201, 1202**

### Hinge, Full Mortise
- **TA2714**

### Storeroom Lock
- **ML2057 NSA LC**

### Mort. Cylinder
- **- match Owner's existing Best key system**

### Surface Closer
- **DC6200 - pull side mount**

### Kick Plate
- **K1050 10" high CSK BEV**

### Door Stop & Holder
- **490**

### Silencer
- **608 / 609**

**Notes:**
- Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.
- Set: **47.0**

**DOOR HARDWARE**

---

**087100 - 47**
2 Hinge, Full Mortise | TA2714 5" x 4-1/2" | US26D | MK
1 Storeroom Lock | ML2057 NSA LC | 626 | RU
1 Mort. Cylinder | - match Owner's existing Best key system | 626 | BE
1 Surface Closer | DC6210 A4 | 689 | RU
1 Kick Plate | K1050 10" high BEV CSK | US32D | RO
1 Smoke / Sound Seal | S88D - head and jambs | PE
3 Silencer | 608 / 609 | RO

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

**Set: 48.0**

Doors: 0244

3 Hinge, Full Mortise | TA2714 | US26D | MK
1 Storeroom Lock | ML2057 NSA LC | 626 | RU
1 Mort. Cylinder | - match Owner's existing Best key system | 626 | BE
1 Surface Closer | DC6200 - pull side mount | 689 | RU
1 Kick Plate | K1050 F 10" high 4BE CSK | US32D | RO
1 Wall Stop | 406 | US32D | RO
1 Smoke / Sound Seal | S88D - head and jambs | PE

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

**Set: 49.0**

Doors: 0238, 0242, 0303

3 Hinge, Full Mortise | TA2714 | US26D | MK
1 Storeroom Lock | ML2057 NSA LC | 626 | RU
1 Mort. Cylinder | - match Owner's existing Best key system | 626 | BE
1 Surface Closer | DC6210 A4 | 689 | RU
1 Kick Plate | K1050 10" high BEV CSK | US32D | RO
1 Smoke / Sound Seal | S88D - head and jambs | PE

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.
## Set: 49.1

### Doors: 1224

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Code</th>
<th>Finish</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>BSP</td>
<td>MK</td>
</tr>
<tr>
<td>1 Storeroom Lock</td>
<td>ML2057 NSA LC</td>
<td>BSP</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>BL</td>
<td>BE</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6210 A4</td>
<td>BSP</td>
<td>RU</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high CSK BEV</td>
<td>BSP</td>
<td>RO</td>
</tr>
<tr>
<td>1 Smoke / Sound Seal</td>
<td>S88D - head and jambs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

## Set: 50.0

### Doors: 0102

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Code</th>
<th>Finish</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US26D</td>
<td>MK</td>
</tr>
<tr>
<td>1 Storeroom Lock</td>
<td>ML2057 NSA LC</td>
<td>626</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6210 A4</td>
<td>689</td>
<td>RU</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>1 Threshold</td>
<td>151A MSES25SS (3&quot; x 1/4&quot;) - position directly under door bottom</td>
<td></td>
<td>PE</td>
</tr>
<tr>
<td>1 Adjustable Sound Seal</td>
<td>379CS TKSP - head and jambs</td>
<td></td>
<td>PE</td>
</tr>
<tr>
<td>1 Conc. Auto. Door Bottom</td>
<td>420APKL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

## Set: 50.1

### Doors: 1110, 1111

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Code</th>
<th>Finish</th>
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</thead>
<tbody>
<tr>
<td>3 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US10B</td>
<td>MK</td>
</tr>
<tr>
<td>1 Storeroom Lock</td>
<td>ML2057 NSA LC</td>
<td>613</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>613</td>
<td>BE</td>
</tr>
<tr>
<td>1 Mounting Bracket</td>
<td>2601AB / 2601C</td>
<td>US28</td>
<td>RO</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6210 A4</td>
<td>690</td>
<td>RU</td>
</tr>
</tbody>
</table>

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.
1 Kick Plate        K1050 10" high BEV CSK        US10B  RO
1 Threshold         151D MSES25SS (3" x 1/4") - position directly under door bottom  PE
1 Adjustable Sound Seal 379DS TKSP - head and jambs  PE
1 Auto. Door Bottom  STC411APK x width of door  PE

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

**Set: 51.0**

Doors: 1205, 1319, 1321, 1332, 1336

3 Hinge, Full Mortise  TA2714  US26D  MK
1 Entrance Lock       ML2053 NSA LC  626  RU
1 Mort. Cylinder      - match Owner's existing Best key system  626  BE
1 Wall Stop           406  US32D  RO
3 Silencer            608 / 609  RO

Notes: Latch operated by lever either side, unless outside lever is locked or unlocked by key outside or thumb turn inside. Outside lever is unlocked by key outside or thumb turn inside. Latch is retracted by key outside when outside lever is locked. Inside lever always free.

**Set: 51.1**

Doors: 2126, 2128

3 Hinge, Full Mortise  TA2714  US26D  MK
1 Entrance Lock       ML2053 NSA LC  626  RU
1 Mort. Cylinder      - match Owner's existing Best key system  626  BE
1 Wall Stop           406  US32D  RO
1 Threshold           151A MSES25SS (3" x 1/4") - position directly under door bottom  PE
1 Adjustable Sound Seal 379CS TKSP - head and jambs  PE
1 Auto. Door Bottom   STC411APK x width of door  PE
3 Silencer            608 / 609  RO

Notes: Latch operated by lever either side, unless outside lever is locked or unlocked by key outside or thumb turn inside. Outside lever is unlocked by key outside or thumb turn inside. Latch is retracted by key outside when outside lever is locked. Inside lever always free.
**Set: 51.2**

Doors: 1344

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Part No.</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US26D</td>
<td>MK</td>
</tr>
<tr>
<td>1 Entrance Lock</td>
<td>ML2053 NSA LC</td>
<td>626</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6200 - pull side mount</td>
<td>689</td>
<td>RU</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>1 Wall Stop</td>
<td>406</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>1 Smoke / Sound Seal</td>
<td>S88D - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Latch operated by lever either side, unless outside lever is locked or unlocked by key outside or thumb turn inside. Outside lever is unlocked by key outside or thumb turn inside. Latch is retracted by key outside when outside lever is locked. Inside lever always free.

**Set: 52.0**

Doors: 1333

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Part No.</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US26D</td>
<td>MK</td>
</tr>
<tr>
<td>1 Classroom Lock</td>
<td>ML2055 NSA LC</td>
<td>626</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6210 A4</td>
<td>689</td>
<td>RU</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>1 Smoke / Sound Seal</td>
<td>S88D - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Function: Latch bolt by lever either side unless outside lever is locked by key outside. Outside lever remains locked unless unlocked by key. Inside lever always free for egress.

**Set: 52.1**

Doors: 1318

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Part No.</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US26D</td>
<td>MK</td>
</tr>
<tr>
<td>1 Entrance Lock</td>
<td>ML2053 NSA LC</td>
<td>626</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6210 A4</td>
<td>689</td>
<td>RU</td>
</tr>
</tbody>
</table>
1 Kick Plate  
K1050 10" high BEV CSK  US32D RO
1 Smoke / Sound Seal  
S88D - head and jambs  PE

Notes: Latch operated by lever either side, unless outside lever is locked or unlocked by key outside or thumb turn inside. Outside lever is unlocked by key outside or thumb turn inside. Latch is retracted by key outside when outside lever is locked. Inside lever always free.

**Set: 53.0**

Doors: 1190.13

3 Hinge, Full Mortise  
TA2714  US26D MK
1 Passage Latch  
ML2010 NSA  626 RU
1 Surface Closer  
DC6200 - pull side mount  689 RU
1 Kick Plate  
K1050 10" high BEV CSK  US32D RO
1 Wall Stop  
406  US32D RO
1 Sound / Smoke Seal  
S773D - head and jambs  PE

**Set: 54.0**

Doors: 3290.07, 4290.01

3 Hinge, Full Mortise  
TA2714  US26D MK
1 Passage Latch  
ML2010 NSA  626 RU
1 Wall Stop  
406  US32D RO
1 Sound / Smoke Seal  
S773D - head and jambs  PE

**Set: 54.1**

Doors: 2290.10

1 Continuous Hinge  
FM300(WT) x hinge width to suit material on face of door  630 MR
1 Passage Latch  
ML2010 NSA  626 RU
1 Wall Stop  
406  US32D RO
1 Sound / Smoke Seal  
S773D - head and jambs  PE

**Set: 55.0**

Doors: 3190.21, 3190.22

3 Hinge, Full Mortise  
TA2714  US26D MK
1 Passage Latch  
ML2010 NSA  626 RU
### Gateway Theater Complex

**HAA Project No. 2016034.00**  
**WSU Project No. 189-178578**

**Bulletin 012 - BP4_2021-08-13**  
**13 August 2021**

#### 1 Surf Overhead Stop
- **Model:** 10-X36  
- **Quantity:** 1  
- **Procedure:** RF

#### 1 Sound / Smoke Seal
- **Model:** S773D - head and jambs  
- **Quantity:** 1  
- **Procedure:** PE

#### 3 Silencer
- **Model:** 608 / 609  
- **Quantity:** 3  
- **Procedure:** RO

**Set: 56.0**

**Doors:** 1325, 1346

<table>
<thead>
<tr>
<th>Product</th>
<th>Model</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US26D MK</td>
</tr>
<tr>
<td>1 Classroom Lock</td>
<td>ML2055 NSA LC</td>
<td>626 RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td></td>
<td>626 BE</td>
</tr>
<tr>
<td>1 Wall Stop</td>
<td>406</td>
<td>US32D RO</td>
</tr>
<tr>
<td>3 Silencer</td>
<td>608 / 609</td>
<td>RO</td>
</tr>
</tbody>
</table>

**Notes:** Function: Latch bolt by lever either side unless outside lever is locked by key outside. Outside lever remains locked unless unlocked by key. Inside lever always free for egress.

#### 1 Surf Overhead Stop
- **Model:** 10-X36  
- **Quantity:** 1  
- **Procedure:** RF

#### 1 Sound / Smoke Seal
- **Model:** S773D - head and jambs  
- **Quantity:** 1  
- **Procedure:** PE

#### 3 Silencer
- **Model:** 608 / 609  
- **Quantity:** 3  
- **Procedure:** RO

**Set: 57.0**

**Doors:** 1113

<table>
<thead>
<tr>
<th>Product</th>
<th>Model</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US10B MK</td>
</tr>
<tr>
<td>1 Classroom Lock</td>
<td>ML2055 NSA LC</td>
<td>613 RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td></td>
<td>613 BE</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6210 A5</td>
<td>690 RU</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US10B RO</td>
</tr>
<tr>
<td>3 Silencer</td>
<td>608 / 609</td>
<td>RO</td>
</tr>
</tbody>
</table>

**Notes:** Function: Latch bolt by lever either side unless outside lever is locked by key outside. Outside lever remains locked unless unlocked by key. Inside lever always free for egress.

#### 1 Surf Overhead Stop
- **Model:** 10-X36  
- **Quantity:** 1  
- **Procedure:** RF

#### 1 Sound / Smoke Seal
- **Model:** S773D - head and jambs  
- **Quantity:** 1  
- **Procedure:** PE

#### 3 Silencer
- **Model:** 608 / 609  
- **Quantity:** 3  
- **Procedure:** RO

**Set: 58.0**

**Doors:** 1230.01, 1230.02

<table>
<thead>
<tr>
<th>Product</th>
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<th>Procedure</th>
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</thead>
<tbody>
<tr>
<td>4 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>BSP MK</td>
</tr>
<tr>
<td>1 Classroom Lock</td>
<td>ML2055 NSA LC</td>
<td>BSP RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
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<td>BL BE</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6210 A3</td>
<td>BSP RU</td>
</tr>
</tbody>
</table>

**DOOR HARDWARE**  
087100 - 53
1 Wall Stop 402 BSP RO
1 Sound / Smoke Seal S773D - head and jambs PE

Notes: Function: Latch bolt by lever either side unless outside lever is locked by key outside. Outside lever remains locked unless unlocked by key. Inside lever always free for egress.

**Set: 59.0**

Doors: 1301

4 Hinge (heavy weight) T4A3786 US26D MK
1 Classroom Lock ML2055 NSA LC 626 RU
1 Mort. Cylinder - match Owner's existing Best key system 626 BE
1 Surf Overhead Stop 10-336 x 5458/5459 - pull side mount 652 RF
1 Kick Plate K1050 10" high BEV CSK US32D RO
1 Threshold 151A MSES25SS (3" x 1/4") - position directly under door bottom PE
1 Adjustable Sound Seal 379CS TKSP - head and jambs PE
1 Auto. Door Bottom STC411APK x width of door PE
3 Silencer 608 / 609 RO

Notes: Function: Latch bolt by lever either side unless outside lever is locked by key outside. Outside lever remains locked unless unlocked by key. Inside lever always free for egress.

**Set: 60.0**

Doors: 1303.01, 4201, 4202

4 Hinge (heavy weight) T4A3786 US26D MK
1 Classroom Lock ML2055 NSA LC 626 RU
1 Mort. Cylinder - match Owner's existing Best key system 626 BE
1 Kick Plate K1050 10" high BEV CSK US32D RO
1 Wall Stop 406 US32D RO
1 Threshold 151A MSES25SS (3" x 1/4") - position directly under door bottom PE
1 Adjustable Sound Seal 379CS TKSP - head and jambs PE
1 Auto. Door Bottom STC411APK x width of door PE
Notes: Function: Latch bolt by lever either side unless outside lever is locked by key outside. Outside lever remains locked unless unlocked by key. Inside lever always free for egress.

**Set: 61.0**

Doors: 1305, 1306, 1309, 1310

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US26D</td>
<td>MK</td>
</tr>
<tr>
<td>1 Classroom Lock</td>
<td>ML2055 NSA LC</td>
<td>626</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6200 - pull side mount</td>
<td>689</td>
<td>RU</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>1 Door Stop &amp; Holder</td>
<td>490</td>
<td>US26D</td>
<td>RO</td>
</tr>
<tr>
<td>3 Silencer</td>
<td>608 / 609</td>
<td></td>
<td>RO</td>
</tr>
</tbody>
</table>

Notes: Function: Latch bolt by lever either side unless outside lever is locked by key outside. Outside lever remains locked unless unlocked by key. Inside lever always free for egress.

**Set: 62.0**

Doors: 1323, 1334

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US26D</td>
<td>MK</td>
</tr>
<tr>
<td>1 Classroom Lock</td>
<td>ML2055 NSA LC</td>
<td>626</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>1 Conc Overhead Stop</td>
<td>2-X36</td>
<td>652</td>
<td>RF</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>3 Silencer</td>
<td>608 / 609</td>
<td></td>
<td>RO</td>
</tr>
</tbody>
</table>

Notes: Function: Latch bolt by lever either side unless outside lever is locked by key outside. Outside lever remains locked unless unlocked by key. Inside lever always free for egress.

**Set: 63.0**

Doors: 1327, 1329.02

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>Finish</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>4 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US26D</td>
<td>MK</td>
</tr>
<tr>
<td>1 Classroom Lock</td>
<td>ML2055 NSA LC</td>
<td>626</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
</tbody>
</table>
1 Surface Closer
   DC6200 - pull side mount       689    RU
1 Kick Plate
   K1050 10" high BEV CSK          US32D    RO
1 Wall Stop
   406                                US32D    RO
1 Smoke / Sound Seal
   S88D - head and jambs          PE

Notes: Function: Latch bolt by lever either side unless outside lever is locked by key outside. Outside lever remains locked unless unlocked by key. Inside lever always free for egress.

Set: 64.0

Doors: 3200, 3204

3 Hinge, Full Mortise
   TA2714                                US26D    MK
1 Classroom Lock
   ML2055 NSA LC                         626    RU
1 Mort. Cylinder
   - match Owner's existing Best key system 626    BE
1 Door Stop & Holder
   490                                   US26D    RO
3 Silencer
   608 / 609                             RO

Notes: Function: Latch bolt by lever either side unless outside lever is locked by key outside. Outside lever remains locked unless unlocked by key. Inside lever always free for egress.

Set: 65.0

Doors: 1305.02, 1306.02, 1309.02, 1310.02, 1315, 1317

4 Hinge, Full Mortise
   TA2714                                US26D    MK
1 Institutional Privacy Lock
   ML2069 NSA M34 M19V LC                626    RU
1 Mort. Cylinder
   - match Owner's existing Best key system 626    BE
1 Foot Operated Door Opener
   FP1230                                US32D    RO
1 Kick Plate
   K1050 10" high BEV CSK               US32D    RO
1 Wall Stop
   406                                   US32D    RO
3 Silencer
   608 / 609                             RO

Notes: ** Provide 180 degree opening at Doors 1315, 1317.

Operation Description: Latchbolt by lever either side, except when lever outside is locked by thumb turn inside.
Operating inside lever or closing door unlocks outside lever.
Key outside retracts latch bolt at all times, even if thumb turn is held in locked position.
Set: 66.0

Doors: 2101

<table>
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<tr>
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<th>Set Numbers</th>
<th>Finish</th>
<th>Notes</th>
</tr>
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<tbody>
<tr>
<td>3 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US26D</td>
<td>MK</td>
</tr>
<tr>
<td>1 Institutional Privacy Lock</td>
<td>ML2069 NSA M34 M19V LC</td>
<td>626</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6200 - pull side mount</td>
<td>689</td>
<td>RU</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>1 Wall Stop</td>
<td>406</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>3 Silencer</td>
<td>608 / 609</td>
<td></td>
<td>RO</td>
</tr>
<tr>
<td>1 Coat Hook</td>
<td>796</td>
<td>US26D</td>
<td>RO</td>
</tr>
</tbody>
</table>

Notes: Latch bolt operated by lever either side, except when outside lever is locked by thumb turn inside. Operating inside lever or closing door unlocks outside lever. Key outside retracts latch at all times, even if thumb turn is held in locked position.

Install coat hook at 48" centerline above floor.

Set: 66.1

Doors: 1128

<table>
<thead>
<tr>
<th>Item</th>
<th>Set Numbers</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Hinge, Full Mortise</td>
<td>TA2714</td>
<td>US10B</td>
<td>MK</td>
</tr>
<tr>
<td>1 Institutional Privacy Lock</td>
<td>ML2069 NSA M34 M19V LC</td>
<td>613</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>613</td>
<td>BE</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6200 - pull side mount</td>
<td>690</td>
<td>RU</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US10B</td>
<td>RO</td>
</tr>
<tr>
<td>1 Wall Stop</td>
<td>406</td>
<td>US10BE</td>
<td>RO</td>
</tr>
<tr>
<td>1 Threshold</td>
<td>151D MSES25SS (3&quot; x 1/4&quot;) - position directly under door bottom</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Adjustable Sound Seal</td>
<td>379DS TKSP - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Auto. Door Bottom</td>
<td>STC411APK x width of door</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Coat Hook</td>
<td>796</td>
<td>US10B</td>
<td>RO</td>
</tr>
</tbody>
</table>

Notes: Latch bolt operated by lever either side, except when outside lever is locked by thumb turn inside. Operating inside lever or closing door unlocks outside lever. Key outside retracts latch at all times, even if thumb turn is held in locked position.

Install coat hook at 48" centerline above floor.
<table>
<thead>
<tr>
<th>Set: 67.0</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Doors: 0110</td>
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</tr>
<tr>
<td>3 Hinge, Full Mortise</td>
<td>TA2714</td>
</tr>
<tr>
<td>1 Institutional Privacy Lock</td>
<td>ML2069 NSA M34 M19V LC</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
</tr>
<tr>
<td>1 Foot Operated Door Opener</td>
<td>FP1230</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6210 A3</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
</tr>
<tr>
<td>1 Wall Stop</td>
<td>406</td>
</tr>
<tr>
<td>3 Silencer</td>
<td>608 / 609</td>
</tr>
</tbody>
</table>

Notes: Operation Description: Latch bolt by lever either side, except when lever outside is locked by thumb turn inside. Operating inside lever or closing door unlocks outside lever. Key outside retracts latch bolt at all times, even if thumb turn is held in locked position.

<table>
<thead>
<tr>
<th>Set: 67.1</th>
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<tbody>
<tr>
<td>Doors: 1101, 1103, 1130</td>
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</tr>
<tr>
<td>3 Hinge, Full Mortise</td>
<td>TA2714</td>
</tr>
<tr>
<td>1 Institutional Privacy Lock</td>
<td>ML2069 NSA M34 M19V LC</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
</tr>
<tr>
<td>1 Foot Pull</td>
<td>FP1230</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6210 A3</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
</tr>
<tr>
<td>1 Wall Stop</td>
<td>406</td>
</tr>
<tr>
<td>3 Silencer</td>
<td>608 / 609</td>
</tr>
</tbody>
</table>

Notes: Operation Description: Latch bolt by lever either side, except when lever outside is locked by thumb turn inside. Operating inside lever or closing door unlocks outside lever. Key outside retracts latch bolt at all times, even if thumb turn is held in locked position.

<table>
<thead>
<tr>
<th>Set: 68.0</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Doors: 1209, 1215, 1237, 1239, 1314, 1316</td>
<td></td>
</tr>
<tr>
<td>4 Hinge, Full Mortise</td>
<td>TA2714</td>
</tr>
<tr>
<td>1 Institutional Privacy Lock</td>
<td>ML2069 NSA M34 M19V LC</td>
</tr>
</tbody>
</table>
1 Mort. Cylinder  - match Owner's existing Best key system  626  BE  
1 Foot Operated Door Opener  FP1230  US32D  RO  
1 Surface Closer  DC6200 - pull side mount  689  RU  
1 Kick Plate  K1050 10" high BEV CSK  US32D  RO  
1 Wall Stop  406  US32D  RO  
3 Silencer  608 / 609  RO  

Notes: Operation Description: Latch bolt by lever either side, except when lever outside is locked by thumb turn inside. Operating inside lever or closing door unlocks outside lever. Key outside retracts latch bolt at all times, even if thumb turn is held in locked position.

Set: 69.0

Doors: 0101

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hinge (heavy weight)</td>
<td>T4A3786</td>
</tr>
<tr>
<td>Flush Bolt</td>
<td>555 / 557</td>
</tr>
<tr>
<td>Dust Proof Strike</td>
<td>570</td>
</tr>
<tr>
<td>Storeroom Lock</td>
<td>ML2057 NSA LC</td>
</tr>
<tr>
<td>Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
</tr>
<tr>
<td>Door Stop &amp; Holder</td>
<td>490</td>
</tr>
<tr>
<td>Silencer</td>
<td>608 / 609</td>
</tr>
</tbody>
</table>

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

Set: 70.0

Doors: 1235.02

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hinge (heavy weight)</td>
<td>T4A3786</td>
</tr>
<tr>
<td>Hinge, Spring</td>
<td>1502 4-1/2&quot; x 4-1/2&quot;</td>
</tr>
<tr>
<td>Comb. Flush Bolt Set</td>
<td>2845 (HM) / 2945 (WD)</td>
</tr>
<tr>
<td>Dust Proof Strike</td>
<td>570</td>
</tr>
<tr>
<td>Storeroom Lock</td>
<td>ML2057 NSA LC</td>
</tr>
<tr>
<td>Mort. Cylinder</td>
<td>- match Owner's existing Best key system 626  BE</td>
</tr>
<tr>
<td>Mounting Bracket</td>
<td>2601AB / 2601C</td>
</tr>
<tr>
<td>Surface Closer</td>
<td>DC6210 A4</td>
</tr>
<tr>
<td>Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
</tr>
<tr>
<td>Threshold</td>
<td>151A MSES25SS (3&quot; x 1/4&quot;)</td>
</tr>
</tbody>
</table>

DOOR HARDWARE 087100 - 59
position directly under door bottom

1 Adjustable Sound Seal 379CS TKSP - head and jambs PE
2 Auto. Door Bottom STC411APK x width of door PE
1 Adjustable Astragal Set 351C/CS x TKSP x height of doors PE

Notes: ** Install mounting bracket 2601AB/C for door closer on active leaf to avoid conflict with adjustable sound seal.

Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

**Set: 71.0**

Doors: 2233, 2234, 2315

6 Hinge (heavy weight) T4A3786 US26D MK
1 Comb. Flush Bolt Set 2845 (HM) / 2945 (WD) US26D RO
1 Dust Proof Strike 570 US26D RO
1 Storeroom Strike ML2057 NSA LC 626 RU
1 Mort. Cylinder - match Owner's existing Best key system 626 BE
1 Coordinator 2672 US28 RO
1 Filler Bar FB-1 / FB-2 US28 RO
1 Mounting Bracket 2601AB / 2601C US28 RO
2 Surface Closer DC6210 A4 689 RU
2 Kick Plate K1050 10" high BEV CSK US32D RO
1 Smoke / Sound Seal S88D - head and jambs PE
1 Meeting Edge Seal S772C x height of door PE

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

**Set: 72.0**

Doors: 1390.01C

4 Hinge, Full Mortise TA2714 US26D MK
1 Storeroom Lock ML2057 NSA LC 626 RU
1 Mort. Cylinder - match Owner's existing Best key system 626 BE
1 Surface Closer DC6210 A4 689 RU
1 Kick Plate K1050 10" high BEV CSK US32D RO
1 Smoke / Sound Seal   S88D - head and jambs   PE

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

**Set: 73.0**

Doors: 3190.30

3 Hinge (heavy weight)   T4A3786   US26D   MK
1 Passage Latch   ML2010 NSA M92   626   RU  
1 Surface Closer   DC6200 - pull side mount   689   RU
1 Kick Plate   K1050 10" high BEV CSK   US32D   RO
1 Wall Stop   406   US32D   RO
1 Threshold   151A MSES25SS (3" x 1/4") - position directly under door bottom   PE
1 Adjustable Sound Seal   379CS TKSP - head and jambs   PE
1 Auto. Door Bottom   STC411APK x width of door   PE
1 Electric Power Transfer   CEPT-10   SU  
1 ElectroLynx Harness   QC-C1500P (power transfer or electric strike to junction box above)   MK  
1 ElectroLynx Harness   QC-C (power transfer to lock or electric strike location)   MK  
1 Push Button   PBA   SU  
1 Power Supply   BPS-24 (amp capacity as required)   SU  

Notes: Passage lever trim. Free access both directions. When orchestra pit is in operation, electromagnetic lock is energized and door is locked. Turning lever on orchestra side shall unlock electromagnetic lock for access to trap room. Push button in orchestra pit turns off the power to electromagnetic lock and door is unlocked.

System to be designed by theatre consultant.

**Set: 74.0**

Doors: 3190.20

3 Hinge (heavy weight)   T4A3786   US26D   MK
1 Passage Latch   ML2010 NSA M92   626   RU  
1 Mounting Bracket   2601AB / 2601C   US28   RO
1 Surface Closer   DC6210 A4   689   RU
1 Kick Plate   K1050 10" high BEV CSK   US32D   RO
<table>
<thead>
<tr>
<th>Item Description</th>
<th>Model</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Threshold</td>
<td>151A MSES25SS (3&quot; x 1/4&quot;)</td>
<td>PE</td>
</tr>
<tr>
<td>1 Adjustable Sound Seal</td>
<td>379CS TKSP - head and jambs</td>
<td>PE</td>
</tr>
<tr>
<td>1 Auto. Door Bottom</td>
<td>STC411APK x width of door</td>
<td>PE</td>
</tr>
<tr>
<td>1 Electric Power Transfer</td>
<td>CEPT-10</td>
<td>SU</td>
</tr>
<tr>
<td></td>
<td>QC-C1500P (power transfer or electric strike to junction box above)</td>
<td>MK</td>
</tr>
<tr>
<td>1 ElectroLynx Harness</td>
<td>QC-C (power transfer to lock or electric strike location)</td>
<td>MK</td>
</tr>
<tr>
<td>1 Push Button</td>
<td>PBA</td>
<td>SU</td>
</tr>
<tr>
<td>1 Power Supply</td>
<td>BPS-24 (amp capacity as required)</td>
<td>SU</td>
</tr>
</tbody>
</table>

Notes: Passage lever trim. Free access both directions.
When orchestra pit is in operation, electromagnetic lock is energized and door is locked. Turning lever on orchestra side shall unlock electromagnetic lock for access to trap room.
Push button in orchestra pit turns off the power to electromagnetic lock and door is unlocked.

System to be designed by theatre consultant.

**Set: 75.0**

Doors: 3290.05, 3290.06, 3290.15

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Model</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Hinge (heavy weight)</td>
<td>T4A3786</td>
<td>US26D</td>
</tr>
<tr>
<td>1 Passage Latch</td>
<td>ML2010 NSA</td>
<td>626</td>
</tr>
<tr>
<td>1 Surface Closer</td>
<td>DC6210 A4</td>
<td>689</td>
</tr>
<tr>
<td>1 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
</tr>
<tr>
<td>1 Smoke / Sound Seal</td>
<td>S88D - head and jambs</td>
<td>PE</td>
</tr>
</tbody>
</table>

**Set: 76.0**

Doors: 1348

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Model</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Hinge (heavy weight)</td>
<td>T4A3786</td>
<td>US26D</td>
</tr>
<tr>
<td>1 Flush Bolt</td>
<td>555 / 557</td>
<td>US26D</td>
</tr>
<tr>
<td>1 Dust Proof Strike</td>
<td>570</td>
<td>US26D</td>
</tr>
<tr>
<td>1 Top Flush Bolt</td>
<td>555-24</td>
<td>US26D</td>
</tr>
<tr>
<td>1 Classroom Lock</td>
<td>ML2055 NSA LC</td>
<td>626</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
</tr>
<tr>
<td>2 Surf Overhead Stop</td>
<td>9-X36</td>
<td>652</td>
</tr>
<tr>
<td>2 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
</tr>
</tbody>
</table>

DOOR HARDWARE 087100 - 62
2 Silencer  608 / 609  RO

Notes: Function: Latch bolt by lever either side unless outside lever is locked by key outside. Outside lever remains locked unless unlocked by key. Inside lever always free for egress.

Set: 77.0

Doors: 1190.06, 1190.14

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Description</th>
<th>Finish 1</th>
<th>Finish 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 Hinge, Full Mortise, Hvy Wt</td>
<td>T4A3786</td>
<td>US10B</td>
<td>MK</td>
</tr>
<tr>
<td>2 Door Pull</td>
<td>RM3300-72 Mtg-Type 12XHD</td>
<td>US10B</td>
<td>RO</td>
</tr>
<tr>
<td>2 Push Plate</td>
<td>RM5598B</td>
<td>US10B</td>
<td>RO</td>
</tr>
<tr>
<td>2 Surface Closer</td>
<td>DC6210 A3</td>
<td>690</td>
<td>RU</td>
</tr>
<tr>
<td>2 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US10B</td>
<td>RO</td>
</tr>
<tr>
<td>2 Wall Stop</td>
<td>406</td>
<td>US10BE</td>
<td>RO</td>
</tr>
<tr>
<td>1 Threshold</td>
<td>151D MSES25SS (3&quot; x 1/4&quot;) - position directly under door bottom</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Sound / Smoke Seal</td>
<td>S773D - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>2 Auto. Door Bottom</td>
<td>STC411APK x width of door</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Meeting Edge Seal</td>
<td>S772C x height of door</td>
<td>PE</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ** Counter sink thru-bolt head flush into push side face of door.
** Provide pull side mount (regular arm) door closers for Doors 1290.07 and 1290.13.

Set: 77.1

Doors: 1290.07, 1290.13

<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Description</th>
<th>Finish 1</th>
<th>Finish 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Hinge (heavy weight)</td>
<td>T4A3786</td>
<td>US26D</td>
<td>MK</td>
</tr>
<tr>
<td>2 Pull</td>
<td>RM2400-72 Mtg-Type 12XHD</td>
<td>BSP</td>
<td>RO</td>
</tr>
<tr>
<td>2 Push Plate</td>
<td>RM5598B</td>
<td>BSP</td>
<td>RO</td>
</tr>
<tr>
<td>2 Surface Closer</td>
<td>DC6210 A3</td>
<td>BSP</td>
<td>RU</td>
</tr>
<tr>
<td>2 Kick Plate</td>
<td>K1050 10&quot; high CSK BEV</td>
<td>BSP</td>
<td>RO</td>
</tr>
<tr>
<td>2 Wall Stop</td>
<td>402</td>
<td>BSP</td>
<td>RO</td>
</tr>
<tr>
<td>1 Threshold</td>
<td>151BSP MSES25SS (3&quot; x 1/4&quot;) - position directly under door bottom</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Sound / Smoke Seal</td>
<td>S773D - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>2 Auto. Door Bottom</td>
<td>STC411APK x width of door</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Meeting Edge Seal</td>
<td>S772C x height of door</td>
<td>PE</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ** Counter sink thru-bolt head flush into push side face of door.
** Provide pull side mount (regular arm) door closers for Doors 1290.07 and 1290.13.
### Set: 78.0

**Doors:** 1190.20, 1190.21

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Hinge, Full Mortise, Hvy Wt</td>
<td>T4A3786</td>
<td>US10B MK</td>
<td></td>
</tr>
<tr>
<td>2 Door Pull</td>
<td>RM3300-72 Mtg-Type 12XHD</td>
<td>US10B RO</td>
<td></td>
</tr>
<tr>
<td>2 Push Plate</td>
<td>RM5598B</td>
<td>US10B RO</td>
<td></td>
</tr>
<tr>
<td>2 Surface Closer</td>
<td>DC6210 A4</td>
<td>690 RU</td>
<td></td>
</tr>
<tr>
<td>2 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US10B RO</td>
<td></td>
</tr>
<tr>
<td>1 Threshold</td>
<td>151D MSES25SS (3&quot; x 1/4&quot;) - position directly under door bottom</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Sound / Smoke Seal</td>
<td>S773D - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>2 Auto. Door Bottom</td>
<td>STC411APK x width of door</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Meeting Edge Seal</td>
<td>S772C x height of door</td>
<td>PE</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** **Counter sink thru-bolt head flush into push side face of door.**

### Set: 79.0

**Doors:** 1290.16A

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Hinge (heavy weight)</td>
<td>T4A3786</td>
<td>US26D MK</td>
<td></td>
</tr>
<tr>
<td>4 Hinge, Spring</td>
<td>1502 4-1/2&quot; x 4-1/2&quot;</td>
<td>US26D MK</td>
<td></td>
</tr>
<tr>
<td>2 Arm Pull</td>
<td>AP1007</td>
<td>US32D RO</td>
<td></td>
</tr>
<tr>
<td>2 Push Plate</td>
<td>70F</td>
<td>US32D RO</td>
<td></td>
</tr>
<tr>
<td>2 Surface Closer</td>
<td>DC6210 A4</td>
<td>689 RU</td>
<td></td>
</tr>
<tr>
<td>2 Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D RO</td>
<td></td>
</tr>
<tr>
<td>1 Threshold</td>
<td>151A MSES25SS (3&quot; x 1/4&quot;) - position directly under door bottom</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Sound / Smoke Seal</td>
<td>S773D - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>2 Auto. Door Bottom</td>
<td>STC411APK x width of door</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Meeting Edge Seal</td>
<td>S772C x height of door</td>
<td>PE</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** **Counter sink thru-bolt head flush into push side face of door.**

### Set: 80.0

**Doors:** 2290.04

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Continuous Hinge</td>
<td>FM300(WT) x hinge width to suit material on face of door</td>
<td>630 MR</td>
<td></td>
</tr>
<tr>
<td>1 Arm Pull</td>
<td>AP1007</td>
<td>US32D RO</td>
<td></td>
</tr>
</tbody>
</table>
1 Push Plate 70F US32D RO
1 Surface Closer DC6210 A3 689 RU
1 Kick Plate K1050 10" high BEV CSK US32D RO
1 Wall Stop 406 US32D RO
1 Sound / Smoke Seal S773D - head and jambs PE
1 Conc. Auto. Door Bottom 420APKL PE

Notes: ** Provide model STC411 door bottom at Door 2290.04.

** Set: 81.0 **

Doors: 2290.07

4 Hinge (heavy weight) T4A3786 US26D MK
1 Arm Pull AP1007 US32D RO
1 Push Plate 70F US32D RO
1 Surface Closer DC6210 A4 689 RU
1 Kick Plate K1050 10" high BEV CSK US32D RO

** Set: 82.0 **

Doors: 1290.11, 1290.12

4 Hinge (heavy weight) T4A3786 US26D MK
1 Pull RM5530 Mtg-Type 1XHD US26D RO
1 Push Plate RM5598B US26D RO
1 Surface Closer DC6210 A4 689 RU
1 Kick Plate K1050 10" high BEV CSK US32D RO
1 Sound / Smoke Seal S773D - head and jambs PE
1 Auto. Door Bottom STC411APK x width of door PE

Notes: ** Counter sink thru-bolt head flush into push side face of door.

** Set: 82.1 **

Doors: 1190.16, 1190.17

1 Continuous Hinge FM300 (WT) x hinge width to suit material on face of door PC-1 MR
1 Door Pull RM3300-72 Mtg-Type 12XHD US10B RO
1 Push Plate RM5598B US10B RO
1 Surface Closer DC6210 A4 690 RU
1 Kick Plate K1050 10" high BEV CSK US10B RO
1 Sound / Smoke Seal  S773D - head and jambs  PE
1 Auto. Door Bottom  STC411APK x width of door  PE

Notes: ** Counter sink thru-bolt head flush into push side face of door.

Set: 83.0

Doors: 0240.02

6 Hinge (heavy weight)  T4A3786  US26D  MK
2 Electromagnetic Lock  - Provided by Stage Lift Contractor  OT
2 Fire Rated Multi-Point Lock  MP9800AxE10xN10 N M55  626  RU
2 Arm Pull  AP1007  US32D  RO
2 Push Plate  20F  US32D  RO
2 Surface Closer  DC6210 A4  689  RU
2 Kick Plate  K1050 10" high BEV CSK  US32D  RO
1 Sound / Smoke Seal  S773D - head and jambs  PE
2 Conc. Auto. Door Bottom  420APKL  PE
1 Adjustable Astragal Set  351C/CS x TKSP x height of doors  PE
1 Exit Push Button  - Provided by Stage Lift Contractor  OT
1 Exit Motion Sensor  - Provided by Stage Lift Contractor  OT

Set: 84.0

Doors: 0290.06, 0290.17

2 Hinge (heavy weight)  T4A3786  US26D  MK
1 Hinge, Full Mortise, Hvy Wt  T4A3786 x CC2-18 ga.  US26D  MK  ⚡
1 Rim Exit Device, Passage  43 55 8815 ETL  US32D  SA  ⚡
1 Electromagnetic Lock  - Provided by Stage Lift Contractor  OT
1 Surface Closer  DC6200 - pull side mount  689  RU
1 Kick Plate  K1050 10" high BEV CSK  US32D  RO
1 Wall Stop  406  US32D  RO
1 Sound / Smoke Seal  S773D - head and jambs  PE
1 Exit Push Button  - Provided by Stage Lift Contractor  OT
1 Exit Motion Sensor  - Provided by Stage Lift Contractor  OT

Set: 85.0

Doors: 1290.16B

4 Hinge (heavy weight)  T4A3786  US26D  MK

DOOR HARDWARE  087100 - 66
<table>
<thead>
<tr>
<th>Item Description</th>
<th>Model Number</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm Pull</td>
<td>AP1007</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>Push Plate</td>
<td>70F</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>Surface Closer</td>
<td>DC6210 A4</td>
<td>689</td>
<td>RU</td>
</tr>
<tr>
<td>Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>Sound / Smoke Seal</td>
<td>S773D - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Auto. Door Bottom</td>
<td>STC411APK x width of door</td>
<td>PE</td>
<td></td>
</tr>
</tbody>
</table>

**Set: 86.0**

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Model Number</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hinge (heavy weight)</td>
<td>T4A3786</td>
<td>US26D</td>
<td>MK</td>
</tr>
<tr>
<td>Conc Overhead Stop</td>
<td>1-X36</td>
<td>652</td>
<td>RF</td>
</tr>
<tr>
<td>Surface Closer</td>
<td>DC6220 top jamb x mounting plate to suit application</td>
<td>689</td>
<td>RU</td>
</tr>
<tr>
<td>Kick Plate</td>
<td>K1050 10&quot; high BEV CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>Threshold</td>
<td>151A MSES25SS (3&quot; x 1/4&quot;) - position directly under door bottom</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Adjustable Sound Seal</td>
<td>379CS TKSP - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>Conc. Auto. Door Bottom</td>
<td>420APKL</td>
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**Set: 87.0**

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Model Number</th>
<th>Finish</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Hinge</td>
<td>HG305 x CTP x AS</td>
<td>630</td>
<td>MR</td>
</tr>
<tr>
<td>Continuous Hinge</td>
<td>HG305 x AS</td>
<td>630</td>
<td>MR</td>
</tr>
<tr>
<td>Flush Bolt</td>
<td>555 / 557</td>
<td>US26D</td>
<td>RO</td>
</tr>
<tr>
<td>Dust Proof Strike</td>
<td>570</td>
<td>US26D</td>
<td>RO</td>
</tr>
<tr>
<td>Top Flush Bolt</td>
<td>555-36</td>
<td>US26D</td>
<td>RO</td>
</tr>
<tr>
<td>Fail Secure Lock</td>
<td>ML20906-SEC NSA M92 LC</td>
<td>626</td>
<td>RU, BE</td>
</tr>
<tr>
<td>Mort. Cylinder</td>
<td>match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>Armor Plate</td>
<td>K1050(F) 36&quot; high 4BE CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>Door Stop &amp; Holder</td>
<td>490</td>
<td>US26D</td>
<td>RO</td>
</tr>
<tr>
<td>Silencer</td>
<td>608 / 609</td>
<td>RO</td>
<td></td>
</tr>
<tr>
<td>Door Contact</td>
<td>1078D (DPDT) - 1&quot; diameter concealed</td>
<td>OT</td>
<td></td>
</tr>
<tr>
<td>Electric Power Transfer</td>
<td>CEPT-10</td>
<td>SU</td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td>BPS-24 (amp capacity as required)</td>
<td>SU</td>
<td></td>
</tr>
<tr>
<td>Card Reader</td>
<td>- Provided by Security Contractor</td>
<td>00</td>
<td></td>
</tr>
</tbody>
</table>
Notes: Door normally closed and locked. Fail secure lockset - Valid use of card reader exterior side of door temporarily unlocks lever to allow passage through door.
Request to exit switch built into inside lever function for shunting of door monitoring upon egress.
Key override outside retracts latch bolt.
Inside lever always free.

Set: 88.0

Doors: 1313.01

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Set</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>2 Continuous Hinge</td>
<td>HG305 x AS</td>
<td>630</td>
<td>MR</td>
</tr>
<tr>
<td>1 Comb. Flush Bolt Set</td>
<td>2845 (HM) / 2945 (WD)</td>
<td>US26D</td>
<td>RO</td>
</tr>
<tr>
<td>1 Dust Proof Strike</td>
<td>570</td>
<td>US26D</td>
<td>RO</td>
</tr>
<tr>
<td>1 Storeroom Lock</td>
<td>ML2057 NSA LC</td>
<td>626</td>
<td>RU</td>
</tr>
<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>626</td>
<td>BE</td>
</tr>
<tr>
<td>1 Coordinator</td>
<td>2672</td>
<td>US28</td>
<td>RO</td>
</tr>
<tr>
<td>1 Filler Bar</td>
<td>FB-1 / FB-2</td>
<td>US28</td>
<td>RO</td>
</tr>
<tr>
<td>2 Mounting Bracket</td>
<td>2601AB / 2601C</td>
<td>US28</td>
<td>RO</td>
</tr>
<tr>
<td>2 Surface Closer</td>
<td>DC6210 A3</td>
<td>689</td>
<td>RU</td>
</tr>
<tr>
<td>2 Armor Plate</td>
<td>K1050(F) 36&quot; high 4BE CSK</td>
<td>US32D</td>
<td>RO</td>
</tr>
<tr>
<td>2 Electromagnetic Holder</td>
<td>994M</td>
<td>689</td>
<td>RF</td>
</tr>
<tr>
<td>1 Smoke / Sound Seal</td>
<td>S88D - head and jambs</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>1 Meeting Edge Seal</td>
<td>S772C x height of door</td>
<td>PE</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ** Provide hinges to suit 180 degree opening.

Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

Doors held open by electromagnetic door holders on adjacent walls. Power for electromagnetic holders shall be connected to fire alarm system in order that doors close immediately upon activation of fire alarm.

(Electromagnetic holder has tri-volt coils for field selectable power: 120VAC, 24VAC/DC, 12VDC)

Set: 89.0

Doors: 1390.06B

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Set</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Continuous Hinge</td>
<td>HG305 x AS</td>
<td>630</td>
<td>MR</td>
</tr>
<tr>
<td>1 Comb. Flush Bolt Set</td>
<td>2845 (HM) / 2945 (WD)</td>
<td>US26D</td>
<td>RO</td>
</tr>
<tr>
<td>1 Dust Proof Strike</td>
<td>570</td>
<td>US26D</td>
<td>RO</td>
</tr>
<tr>
<td>1 Storeroom Lock</td>
<td>ML2057 NSA LC</td>
<td>626</td>
<td>RU</td>
</tr>
</tbody>
</table>

DOOR HARDWARE 087100 - 68
1 Mort. Cylinder
- match Owner's existing Best key system 626 BE
1 Coordinator 1700 US28 RO
2 Surf Overhead Stop 9-X36 x LS 652 RF
2 Surface Closer DC62930 x ET 689 RU
2 Armor Plate K1050(F) 36" high 4BE CSK US32D RO
1 Smoke / Sound Seal S88D - head and jambs PE
1 Meeting Edge Seal S772C x height of door PE

Notes: Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.

Door held open by electromechanical hold open door closer. Install overhead stop with dead stop feature ("LS") at 5 degrees beyond hold open point of door closer. Door shall be reinforced for surface mount door hardware. Thru-bolt mounting of closer body and overhead stop are not permitted.

Power for electromechanical hold open closer shall be connected to fire alarm system in order that door shall close immediately upon activation of fire alarm.

Set: 90.0

Doors: 1227

2 Pivot Set L117 626 RF
4 Intermediate Pivot ML19 BSP RF
2 Roller Caster 10602 RF
2 End Caps 10600-019 RF
2 Reinforced Plate 10600-025/028 RF
1 Surface Bolt - Bottom 585-24 US26D RO
1 Spring Bolt Richards Wilcox 0514.00038 x long chain OT
1 Storeroom Lock ML2057 NSA LC 626 RU
1 Mort. Cylinder - match Owner's existing Best key system 626 BE
2 Heavy Duty Door Stop 465 - floor mount US26D RO

Notes: ** 180 degree opening.

Function: Latch bolt operated by key outside or lever inside. Outside lever always rigid. Inside lever always free for egress.
## Set: 91.0

### Doors: 1240

1 Sliding Door Hardware

<table>
<thead>
<tr>
<th>Series 2651</th>
<th>Bi-Parting Sliding Door Hardware kit – 2500 Lbs Capacity.</th>
<th>Part number: 2651.00012</th>
</tr>
</thead>
<tbody>
<tr>
<td>RW</td>
<td>626</td>
<td>HDW</td>
</tr>
</tbody>
</table>

Notes: ** (2) 6’x18’ sliding door panels on Stagehouse side with CD-4 (rated) on corridor side. (12’x18’ opening). Contractor to confirm door panel weight and appropriate Hardware Kit weight capacity.

## Set: 92.0

### Doors: 0104, 0105, 0106, 0107, 0108, 0109, 0110.01, 0111.02, 0112, 0121, 0123, 0124, 0126, 0187.20A, 0187.20B, 0187.20C, 0187.20D, 0187.20E, 0187.20F, 0187.20G, 0187.20H, 0187.20I, 0190.03A, 0190.03B, 0190.03C, 0190.03D, 0190.07, 0190.08, 0190.10A, 0190.10B, 0190.10C, 0190.10D, 0190.14, 0190.14A, 2100.02, 2105.01, 2105.02, 2109, 2122, 2190.05, 2190.15, 2190.22, 3123.A, 3123.B, 3123.C

1 Cylinder - to suit existing lock (site verify) 626 BE
1 Reuse Balance of Existing Door Hardware OT

## Set: 92.1

### Doors: 1127.1

1 Institutional Privacy Lock ML2069 NSA M34 M19V LC 613 RU
1 Mort. Cylinder - match Owner's existing Best key system 613 BE
1 Cylinder - to suit existing lock (site verify) 626 BE
1 Foot Pull FP1230 US10BE RO
1 Reuse Balance of Existing Door Hardware OT

** Site verify compatibility of privacy lock with existing door preparation and frame preparation prior to supply and install.

## Set: 92.2

### Doors: 1121, 1126.01, 1126.02, 1127, 1129

1 Cylinder - to suit existing lock (site verify) 606 BE
1 Threshold 151D MSES25SS (3" x 1/4") - position directly under door bottom PE
1 Adjustable Sound Seal 379DS TKSP - head and jambs PE
1 Auto. Door Bottom STC411APK x width of door PE

DOOR HARDWARE 087100 - 70
1 Reuse Balance of Existing Door Hardware OT

**Set: 92.3**
Doors: 1100.01, 1107, 1108, 1109, 1111.02, 1111.1, 1117, 1119, 1125, 1190.03B, 1190.03D, 1190.09, 1190.10, 1190.11, 1190.12, 1190.12.1, 1190.25A, 1190.25C

1 Cylinder - to suit existing lock (site verify) 606 BE
1 Reuse Balance of Existing Door Hardware OT

**Set: 92.4**
Doors: 2123.01, 2123.02, 2124.01, 2124.02, 2127.01

1 Cylinder - to suit existing lock (site verify) 626 BE
1 Threshold 151A MSES25SS (3" x 1/4") - position directly under door bottom PE
1 Adjustable Sound Seal 379CS TKSP - head and jambs PE
1 Auto. Door Bottom STC411APK x width of door PE
1 Reuse Balance of Existing Door Hardware OT

**Set: 93.0**
Doors: 1100.A, 1100.B

1 Cylinder - to suit existing lock (site verify) 606 BE
1 Sound / Smoke Seal S773D - head and jambs PE
1 Meeting Edge Seal S772C x height of door PE
1 Reuse Balance of Existing Door Hardware OT

**Set: 94.0**
Doors: 1104

1 Cylinder - to suit existing lock (site verify) 606 BE
1 Reuse Balance of Existing Door Hardware OT
1 Card Reader - Provided by Security Contractor 00

Notes: Door has existing electric latch.

**Set: 95.0**
Doors: 1190.03F

1 Cylinder - to suit existing lock (site verify) 626 BE
1 Reuse Balance of Existing Door Hardware OT
1 Pneumatic Tubing - provide for existing door operator (site verify) OT
1 Pneumatic Controller / Compressor - provide for existing door operator (site verify) OT

Set: 96.0

Doors: 1190.22A

2 Electric Power Transfer EPT10 SP313 FA ≠
1 Mullion KR9954 SP313 VD
1 Exit Device (nightlatch) RX-LC SD-EL 98NL less pull US10B VD
1 Exit Device (exit only) LX-RX-LC SD-EL 98EO US10B VD
1 Mort. Cylinder - match Owner's existing Best key system 613 BE
1 Rim Cylinder - match Owner's existing Best key system 613 BE
2 Position Switch MSS-1 SU ≠
1 Power Supply PS914 x 900-2RS (electric latch retraction) VD ≠
1 Reuse Balance of Existing Door Hardware OT
1 Card Reader - Provided by Security Contractor 00

Notes: ** Site verify that above door hardware will work on existing door and frame conditions. Use armored door loop for power transfer if the use of the concealed power transfer (EPT) is not possible.

Operation Description: Doors normally closed and locked. Key outside on active leaf retracts latch bolt. Keyed cylinder inside controls dogging of latch bolt for push / pull operation. Exit devices equipped with electric latch retraction and REX signal switch in push rail for shunting of door monitoring upon egress. Doors can be scheduled for unlock as determined in access control system. Free egress always permitted.

Set: 97.0

Doors: 2102, 2107

1 Foot Operated Door Opener FP1230 US32D RO
1 Reuse Balance of Existing Door Hardware OT

Set: 98.0

Doors: 2110
<table>
<thead>
<tr>
<th>Item</th>
<th>Model/Description</th>
<th>Quantity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Hinge (heavy weight)</td>
<td>T4A3786</td>
<td>2</td>
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<tr>
<td>1 Hinge, Full Mortise, Hvy Wt</td>
<td>T4A3786 x CC8-18 ga.</td>
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<tr>
<td>1 Fail Secure Lock</td>
<td>ML20906-SEC NSA M92 LC</td>
<td>1</td>
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<tr>
<td>1 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1 Position Switch</td>
<td>MSS-1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1 Power Supply</td>
<td>BPS-24 (amp capacity as required)</td>
<td>1</td>
<td></td>
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<tr>
<td>1 Reuse Balance</td>
<td>of Existing Door Hardware</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1 Card Reader</td>
<td>- Provided by Security Contractor</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>** Confirm existing hinges on site prior to submittal of hardware schedule.**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Door normally closed and locked.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fail secure lockset - Valid use of card reader exterior side of door temporarily unlocks lever to allow passage through door. Request to exit switch built into inside lever function for shunting of door monitoring upon egress. Key override outside retracts latch bolt. Inside lever always free.</td>
<td></td>
<td></td>
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<td>Notes:</td>
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<tr>
<td>** Set: 99.0</td>
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<td>Doors: 2126.1</td>
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<tr>
<td>1 Sliding Door Hdwe</td>
<td>PF28200A - to suit door travel and wall thickness</td>
<td>1</td>
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<td>1 Mortise Deadlock</td>
<td>2331</td>
<td>1</td>
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<tr>
<td>2 Mort. Cylinder</td>
<td>- match Owner's existing Best key system</td>
<td>2</td>
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<tr>
<td>2 Flush Pull</td>
<td>95B</td>
<td>2</td>
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<td>Notes:</td>
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<td>** Set: 100.0</td>
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Doors: 1200

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<thead>
<tr>
<th>Continuous Hinge</th>
<th>BLFM-SLF-HD1 x PT</th>
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<tbody>
<tr>
<td>Mullion</td>
<td>KR9954</td>
<td>SP28 VD</td>
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<tr>
<td>Exit Only</td>
<td>LX-RX-LC SD-QEL 98EO</td>
<td>315 VD</td>
</tr>
<tr>
<td>Mort. Cylinder</td>
<td>match Owner's existing Best key system</td>
<td>626 BE</td>
</tr>
</tbody>
</table>

END OF SECTION 087100
SECTION 08 80 00
GLAZING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Monolithic glass (GL-1) and (GL-2)
   2. Special monolithic glass (GL-5).
   3. Laminated glass (GL-12).
   4. Insulating laminated glass (GL-21).
   5. Unframed mirrors (GL-91).

1.2 DEFINITIONS
A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings:
   1. Review curtain wall and window shop drawings and submit acceptance of details as suitable for proposed glass products.
C. Samples: For each type of product; 12 inches square.
D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS
A. Insulating Glass Certification: Submit data verifying compliance with IGCC, Class A level.
B. Compatibility Certification: After testing and review, certify compatibility of materials in contact and in close proximity to glazing sealant materials.
C. Wind Pressure and Thermal Stress Analysis: Submit thermal stress analysis of glass where thermal stress may occur.
D. Qualification Data: For Installer.
E. Product Certificates: For glass and glazing products, from manufacturer.
F. Preconstruction adhesion and compatibility test report.
G. Sample Warranties: For special warranties.
1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association Glazier Certification Program as Level 2 (Senior Glaziers) or Level 3 (Master Glaziers).

B. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the inspecting and testing agency, Insulating Glass Certification Council.

1.1 MOCKUPS

A. Mockups: Before glazing, build mockups for each glass product indicated below to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the combination with curtain wall mockup requirements.
2. Build mockups with the glass to match glazing systems required for Project, including typical lite size, framing systems, and glazing methods:
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed.

1.2 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer’s written instructions for corrective measures including the use of specially formulated primers.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.
1.4 FIELD CONDITIONS
A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1.5 GLASS WARRANTY
A. Warranty for Insulating Units: Warranty sealed insulating glass units for minimum period of ten (10) years, with manufacturer's replacement guarantee, covering as minimum: Defective or failure of seal; material vision obstruction as result of dust collection or film formation between panels or other similar failure and the following specific conditions:
   1. Reflective glass whose reflective coating cracks, peels or discolors shall be replaced at no charge (material only) for minimum ten (10) year period beginning on date of Substantial Completion.
   2. In addition to replacement of insulated units, provide removal and reinstallation of new units without cost to Owner during first five (5) years of guarantee.
B. Spandrel Glass Warranty: Spandrel glass whose opacifier delaminates, cracks, peels, wrinkles, discolors, or stains shall be replaced at no charge (material only) for minimum five (5) year period beginning on date of Substantial Completion.
C. Laminated Glass Warranty: Laminated glass that delaminates shall be replaced at no charge (material only) for minimum 5 years beginning on date of Substantial Completion.
D. Glazing installer shall coordinate glass and glazing installation with framing systems, and install glass and glazing in accordance with manufacturer's instructions, so that guarantee is maintained.

PART 2 PRODUCTS
2.1 PERFORMANCE REQUIREMENTS
A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
B. Glass Design: Glass thicknesses indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites for various size openings in nominal thicknesses indicated, but not less than thicknesses complying with ASTM E 1300 and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
   1. Specified Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour at 33 feet above grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.4.2, "Analytic Procedure," based on mean roof heights above grade indicated on Drawings.
   2. Specified Design Snow Loads: As indicated, but not less than snow loads applicable to Project, required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 7, "Snow Loads."
   3. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
      a. Load Duration: 60 seconds or less.
   4. Maximum Lateral Deflection: For the following types of glass supported on all four edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.
      a. For monolithic-glass lites heat treated to resist wind loads.
b. For insulating glass.

c. For laminated-glass lites.

5. Minimum Glass Thickness for Exterior Lites: Not less than 6 mm.

6. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.

2. For laminated-glass lites, properties are based on products of construction indicated.

3. For insulating-glass units, properties are based on units with lites 6 mm thick and a nominal 1/2"-wide interspace.

4. Center-of-Glass U-Values: NFRC 100 methodology using LBL-35298 WINDOW 4.1 computer program, expressed as Btu/ sq. ft. x h x deg F.


6. Solar Optical Properties: NFRC 300

E. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

2.2 MANUFACTURERS

A. Single Source Responsibility: Provide materials obtained from one source for each type of insulating glass and glazing product indicated.

B. Manufacturers for Glass Substrate:

1. AGC Glass Company

2. AFG Industries.

3. ACH.

4. Ford Glass.

5. Guardian Industries Corp.

6. Pilkington North America, Inc.

7. Vitro Architectural Glass (formerly PPG).

8. Saint-Gobain.


C. Fabricators for Insulating Glass Units: Refer to Basis of Design as specified in this Section.

2.3 GLASS PRODUCTS

A. Monolithic Glass, General:

1. Specified glass thickness and thickness of individual glass plies are minimum.

2. Provide heat-strengthened as required for wind pressure or thermal stress.

3. Provide fully-tempered complying with ASTM C1048, Kind FT (fully tempered), as required to comply with safety code requirements and as indicated with “T” in the Material Identification Abbreviation.

4. Provide safety glazing labeling, as applicable.
B. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
   1. Construction: Laminate glass with polyvinyl butyral (PVB) interlayer complying with interlayer manufacturer's written recommendations.
   2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
   3. Edges ground smooth for exposed conditions.

C. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3

D. Ceramic-Coated Vision Glass: ASTM C1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in NGA's "Engineering Standards Manual."

E. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.

F. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
   1. Specified glass thickness are minimum.
   2. Provide heat-strengthened lites as required for wind pressure or thermal stress.
   3. Provide fully-tempered complying with ASTM C1048, Kind FT (fully tempered), as required to comply with safety code requirements. Provide safety glazing labeling, as applicable.
   4. Dual Seal: Manufacturer's standard dual sealing system with black colored silicone.
   5. Spacer: Stainless steel, painted black.
   6. Desiccant: Molecular sieve or silica gel, or blend of both.
   7. Glass type locations as indicated on drawings.

2.4 GLAZING SCHEDULE

A. (GL-1) Clear Float Glass: 1/4-inch; ASTM C1036, Type I (transparent glass, flat), Class 1 (clear), Quality-Q3 (glazing select).

B. (GL-1T) Clear Fully-Tempered Float Glass: 1/4-inch; ASTM C1036, Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), and heat-treated to comply with ASTM C1048, Kind FT (fully tempered).

C. (GL-2T) Clear Fully-Tempered Float Glass: 1/2-inch; ASTM C1036, Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), and heat-treated to comply with ASTM C1048, Kind FT (fully tempered).

D. (GL-5) Non-Reflective, Ultra-Clear Glass:
   1. Glass Substrate: 3/8-inch thick, ultra-clear, low-iron float glass with a visible light transmission exceeding 90 percent through a 6.0mm test sample. Inclusions shall not exceed 3 psc/kg. The glass shall be select glazing quality (q3), Type I, Class I, free of defects that affect normal viewing.
   2. Anti-Reflective Coating: On each face, providing residual reflection of less than 1 percent when viewed at a 90 degree angle.

E. (GL-12) Laminated Clear Glass: 1/2-inch unit consisting of 2 plies of 1/4-inch, heat-treated clear glass, laminated with 0.090-inch clear PVB Interlayer.
F. (GL-21) Insulating Vision Glass: 1-inch thick unit as follows:

1. Outboard Lite: 1/4 inch, clear; heat-treated; with high-performance low-emissivity coating applied to No. 2 surface.
2. Airspace: 1/2 inch, argon-filled, with black painted stainless steel spacer
3. Inboard Lite: 1/4 inch, clear; heat-treated.
4. Performance:
   b. Ultraviolet Transmission: 4 percent.
   c. Nighttime Winter U-value: 0.24
   d. Solar Heat Gain Coefficient: 0.27


1. Edge Treatment: Polished mitered edges.
2. Mounting Accessories: Brushed stainless steel (Type 302) mirror clips similar to KV277 at bottom and KV278 at top where indicated.
3. Concealed Fasteners: Mirror mastic as recommended for applicable for specific substrate and mirror configuration, unless otherwise indicated.

2.5 ACCESSORIES

A. Framing for Butt Glazing: Aluminum or stainless steel angles as indicated. Anchor to ceiling and floor substrates with appropriate fasteners in locations as indicated.

B. Setting Blocks: Neoprene, 80 to 90 shore “A” durometer hardness, chemically compatible with glazing sealant or compound, length as recommended by glass manufacturer.

C. Spacers and Shims: Neoprene, 40 to 50 shore “A” durometer hardness, chemically compatible with glazing sealant or compound, length as recommended by glass manufacturer.

D. Glazing Tape: Butyl or silicone preshimmmed tape similar to Tremco 440 Tape.

2.6 GLAZING TAPES

A. Manufacturers:
   1. Bostik.
   2. Pecora.
   3. Tremco.
   4. GE Company.

B. Back-Beding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
   1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

C. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
   1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
   2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.
D. High-Bond Structural Glazing Tape: Pressure-sensitive, conformable acrylic closed-cell foam tape with high-performance acrylic adhesive on both faces, 2.3 mm thick, black color.
   1. Basis of Design for Product Type and Performance: B23F VHB Tape by 3M.
   2. Provide Basis of Design product or other product as recommended by tape Manufacturer for intended use.

2.7 GLAZING SEALANTS

A. Manufacturers:
   1. Dow Corning Corporation.
   2. GE Company.

B. Suitability: Comply with sealant and glass manufacturers’ written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
   1. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruc-tion adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
      a. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant ma-terial behind.
      b. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant’s internal strength.

C. Adhesion Testing: Prior to application of sealants, test each application condition to ensure sealant satisfactorily adheres to substrate.
   1. Conduct test in field or by submission of representative substrate sample to manufacturer for factory test.
   2. Apply sealant to sample substrate and perform hand-pull tab test in accordance with ASTM C1193, Method A.
   3. Determine if primer is required. If so, re-test using primer.

D. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
   1. Compatibility Testing: Prior to application of sealants, test gaskets, spacers, setting blocks, and other glazing accessories being provided for project to determine compatibility with structural silicone sealants.
      a. Submit representative samples of accessories to manufacturer for factory testing.
      b. Perform testing in accordance with ASTM C1087.
      c. Incompatible accessories shall be replaced with ones recommended by and tested by manufacturer as acceptable.

E. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT, G, A, and O; SWRI validation.
   1. Basis of Design Product: Dow Corning Corporation, 795 Silicone Building Sealant

F. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT, G, and A; SWRI validation.
   1. Basis of Design Product: Dow Corning Corporation, 995 Silicone Structural Sealant
G. Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT, G, and A.

2.8 FABRICATION
A. Heat-Treated Float Glass: ASTM C 1048. Fabricate using horizontal roller heating process only. Roll wave distortion parallel to bottom edge of glass as installed. Deviation from flatness at any peak (peak to valley deviation): shall not exceed 0.003 inches in the center of a lite and shall not exceed 0.008 inches within 10.5 inches of the leading or trailing edge.

B. Fully tempered (FT) glass shall be heat soak tested to eliminate the potential of spontaneous breakage due to nickel-sulfite inclusions or other defects that can affect glass performance in place.

C. Insulating Glass Units:
   1. Fabricate using both primary and secondary seals and as otherwise required to comply with the IGCC CBA classification.
   2. Fabricate using glass from the same manufacturer throughout the Project.
   3. Seal Construction: Dual seal design with primary seal of PIB and Silicone Secondary Seal, unless specifically indicated otherwise.

D. Butt-Glazed Glass: Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

PART 3 EXECUTION

3.1 EXAMINATION
A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.
   1. Verify glazing channels are free of burrs, irregularities, and debris.
   2. Verify glass is free of edge damage or face imperfections.
   3. Inspect door and frames to determine that frames, sash, and stops are set true and straight. Sash rabbets and stops shall be clean and dry at time of glazing.
   4. Do not proceed until unsatisfactory conditions have been corrected.

B. Beginning of installation means acceptance of substrate.

3.2 PREPARATION
A. Provide glass manufacturer’s recommended edge clearances when sizing glass.
B. Remove protective coatings from surfaces to be glazed.
C. Clean glass and glazing surfaces to remove dust, oil, and contaminants, and wipe dry.
D. Verify measurements of sash and openings at Project.
   1. Dimensions shown or indicated are given only as a guide for estimating purposes, and actual size shall be determined by measurement of the actual openings. Accurately cut glass to fit openings with proper clearances and setting block height.
E. Coordinate with and check Shop Drawings furnished by other suppliers of Work affecting this Section to avoid field installation problems.
F. Before glazing metal sash, remove oil, lacquer, or other material to which the compound will not readily adhere or which will tend to delaminate from metal and cause a leak through the glazing seal.

3.3 INSTALLATION

A. Comply with glass fabricators recommendations.

B. Except where curtain wall, window, entrance or glass manufacturer recommends otherwise, comply with Flat Glass Marketing Association (FGMA) Sealant Manual and FGMA Glazing Manual.

C. Glaze insulated units as recommended by glass and frame manufacturers.

D. Do not apply glazing materials at temperatures below manufacturer's recommendations or to damp or frosted surfaces. Apply glazing material according to the manufacturer's instructions using proper primers as required.

E. Set glass using neoprene setting blocks and spacers to insure proper edge clearance and uniform beads of compound. Clearances shall conform to FGMA Glazing Manual requirements. Center glass in glazing rabbets.
   1. Butt glazing requirements: Apply mildew resistant silicone sealant to flush depth of joint as indicated by sealant manufacturer.

F. Check openings to confirm proper clearance at perimeters and between glass and stops.
   1. Clean surfaces of rabbet (including stops) and surface of glass which will come into contact with sealant. Use solvents and methods which insure clean, dry surfaces without film or foreign material when sealant is placed.

G. Remove and replace glazing beads carefully to avoid marking or defacing any portion of frame, sash, or fastenings.
   1. Set glass in full bed of glazing tape or sealant. Clean glazing material after stops are installed. Clean excess compound, etc. from glass after setting in conformance with glass manufacturer's recommendations.
   2. If recommended prime surfaces prior to glazing.

H. Set glass with reams (waves) running horizontally. Set glass with factory attached labels in place.

I. Setting Blocks: Place setting blocks at locations recommended by glass manufacturer, generally between 1/4 points and 6 inches from corner, except at glazed doors.
   1. At glazed doors, provide one block at sill, located 3 inches up from edge of glass at hinge side; one block at hinge side jamb, located 3 inches up from lower edge of glass; one block at head, located 3 inches from edge of glass at latch side of door; and, one block at jamb at lock side of door, located 3 inches down from edge of glass at top corner.
   2. Use blocks of length required to properly support glass. Offset approximately 1 inch from shims.

J. Glass Installation in Hollow Metal Frames:
   1. Glaze frames using pre-shimmed tape on both sides. Firmly glaze in place with joints sealed, free of rattles.
   2. Set glass on setting blocks with a full bed of sealant or glazing tape.

K. Glass Installation in Aluminum Frames:
   1. Glaze aluminum frames using preformed EPDM elastomeric glazing extrusion separately or in combination with sealant and pre-shimmed glazing tape in compliance with aluminum frame supplier's recommendations.
   2. Set glass on setting blocks as recommended by manufacturer.
   3. Apply tape and/or sealant to produce uniform sight line even with frame.
4. Set glass in gaskets with corners sealed.

L. Glazing Sealant: Along entire bottom edge of light, and up at least 6 inches at each jamb, gun in continuous full bed of sealant to fill voids.
   1. Fill entire space, full width of pane, full depth of glass, with sufficient sealant to form heel along inside face and edge of glass.
   2. At other edges (top and sides) gun in continuous heel bead of sealant along edges of glass perimeter to set stop against and into, acting as fill between glass and stop.
   3. Immediately after setting glass, at entire perimeter of glass, gun in sealant between stop and glass so space above spacer is completely filled, without voids.
   4. Place sealant flush with daylight edge of stops, with slight watershed at exterior. Provide straight, smooth surface meeting at opening corners with sharp intersection.
   5. Leave no sealant on exposed surfaces of stops and glass.

M. Apply structural sealant carefully in uniform thickness pushing bead ahead of nozzle and making sure that entire cavity is filled. Air pockets or voids along edges are not acceptable.
   1. Tool joint immediately after application.
   2. Tool neatly, forcing sealant into contact with joint sides, eliminating internal voids and insuring good substrate contact.
   3. Do not tool with soap or detergent solutions.
   4. Install silicone structural butt glazing system in accordance with manufacturer’s printed instructions.

N. Mirror installation: As indicated.
   1. Adhere mirrors to substrate with mirror mastic.

3.4 CLEANING

   A. Remove surplus materials.

   B. Final cleaning of glass by Contractor.

END OF SECTION
SECTION 089100
LOUVERS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Shop-fabricated, fixed, extruded aluminum louvers and frames (LVR).
   2. Attachment hardware.
B. Related Sections:
   1. Section 055000 - Metal Fabrications: Steel support framing.
   2. Section 084400 - Aluminum Curtain Walls, Storefronts and Entrances.
   3. Division 23 - Mechanical: Attachment of ducting and blanking out unused louver area.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
   1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion. Include Details to illustrate how the louver frame interfaces and seals to the adjacent primary air and water barrier line.
      a. Locate primary seal on the louver frame to the interior of the frame.
      b. The base flashing is to be full depth with end dams to collect and weep moisture to the exterior.
C. Samples: For each type and color of exposed metal finish.

1.3 QUALITY ASSURANCE
A. Welding Qualifications: Qualify procedures and personnel according to the following:
   2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.4 FIELD CONDITIONS
A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.5 WARRANTY
A. Special Finish Warranty: Provide Manufacturer’s standard 20-year warranty against failure or excessive fading of powder coat finish.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. General: Design and fabricate exterior wall louvers in accordance with AMCA Standard 500 and comply with AMCA Certified Ratings Program.

C. Not Permitted: Vibration harmonics; wind whistles; noises caused by thermal movement; thermal movement transmitted to other building elements; loosening, weakening or fracturing of attachments or components of system.

D. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.

E. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
   1. Wind Loads: Determine loads based on pressures as indicated on Drawings.

F. Windborne-Debris-Impact Resistance: Louvers located within 30 feet of grade shall pass basic-protection, large-missile testing requirements in ASTM E 1996 for Wind Zone 1 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than louvers indicated for use on Project.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 LOUVERS

A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Subject to compliance with specified requirement, provide Basis of Design or provide equivalent products by one of the following:
   1. Airolite Company
   2. Construction Specialties, Inc.
   3. Greenheck Fan Corporation
   4. Industrial Louvers, Inc.
   5. Nystrom Building Products.
   6. Ruskin Company; Tomkins PLC.

   1. Free Area, Minimum: 50%.
   2. Water Penetration Velocity, Minimum: 700 fpm.
   4. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
   5. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
      a. Color: Black.

2.3 FASTENERS, COMPONENTS AND ACCESSORIES

A. Provide fasteners and anchors; screening, flashing and blank-off panel components; and other installation and support accessories required for complete installed assembly.

B. Fasteners: Aluminum or 300 series stainless-steel fasteners, types and sizes to suit unit installation conditions.
C. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

D. Bird Screen: 5/8-inch flattened expanded aluminum mesh, with 0.050-inch extruded aluminum frame.

E. Sill Flashing: Formed from min. 0.050 inch aluminum, with welded side panels

F. Blank-Off Panels, Uninsulated: Metal sheet attached to back of louver.
   1. Aluminum sheet for aluminum louvers, not less than 0.050-inch nominal thickness.
   2. Panel Finish: Same finish type applied to louvers, but black color.
   3. Attach blank-off panels with fasteners as recommended by louver manufacturer.

G. Blank-Off Panels, Insulated: Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.
   1. Thickness: 2 inches.
   2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch nominal thickness.
   3. Insulating Core: Closed-cell polyisocyanurate.
   4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer’s standard channel frames, with corners mitered and with same finish as panels.
   5. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
   6. Attach blank-off panels with fasteners as recommended by louver manufacturer.

H. Steel Shapes: ASTM A36.

I. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer.
   1. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.

D. Provide subsills made of same material as louvers or extended sills for recessed louvers.

E. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
   1. Install bird screens fixed to interior.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

F. Set and tie in to flashings to ensure diversion of moisture to exterior.
   1. Locate primary seal on the louver frame to the interior of the frame.
   2. Provide full-depth base flashing with end dams to collect and weep moisture to the exterior.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required.
   1. Comply with Section 079200 - Joint Protection for sealants applied during louver installation.

3.4 INSTALLED WORK

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
   1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION
SECTION 092200
NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Non-structural metal framing systems for interior assemblies, including:
      a. Interior partitions.
      b. Interior suspended ceiling and soffit systems.
      c. Shaft wall systems.

B. Related Sections:
   1. Section 018198 - Facility Acoustic Performance Requirements.
   2. Section 054000 - Cold-Formed Metal Framing: For interior framing members carrying a lateral (transverse) load exceeding 10 lb/ft^2, a superimposed vertical load exceeding 100 lbf/ft, or a superimposed vertical load exceeding 200 lbs; and members exceeding maximum heights, spans or spacing for non-structural framing as indicated in ASTM C 754 Tables 1-7.

1.2 ACTION SUBMITTALS
A. Product Data:
   1. Submit statement indicating that metal stud manufacturer has reviewed Project documents and that framing supplied conforms to specified requirements.
   2. Evaluation Reports: ICC-ES reports for metal studs and tracks, indicating compliance with specified requirements and building code in effect.

B. EQ Stud Submittals: Comply with the following if submitting EQ studs.
   1. Submit statement indicating that metal stud manufacturer has reviewed Project documents and that framing supplied conforms to specified requirements.
   2. Submit list of completed projects of similar project type and similar wall loading where specific product recommended has been used.
   3. Submit material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

1.3 INFORMATIONAL SUBMITTALS
A. Shop Drawings: Submit in accordance with Section 013300, indicating light gauge framing system. Indicate by plan and elevation, stud framing (spacing, sizes, thicknesses and types), openings, bracing and blocking, fastening and anchorage, strapping, bridging, connection details and reinforcement.

1.4 QUALITY ASSURANCE
A. Perform work in accordance with applicable reference standards unless otherwise indicated.

B. Pre-Installation Conference: Convene a pre-installation meeting at the beginning of the project to review acoustically-rated construction requirements and to coordinate penetrations.
   1. Architect, Contractor, Owner's representative and each trade that may need to penetrate acoustically rated construction or will be involved in construction of acoustically rated partitions and related systems must attend.
2. Review layouts and routing for potential penetrating items, discuss reducing or eliminating penetrating items by considering alternate routing, review construction requirements, details and specifications for acoustically rated construction.
3. A follow-up meeting should be scheduled as needed.
4. This meeting can occur in conjunction with a regular construction progress meeting.
5. Publish meeting minutes highlighting topics discussed, actions items and decision made.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Design framing systems in accordance with American Iron and Steel Institute AISI Standard S220-11 North American Specification for the Design of Cold-Formed Steel Framing - NonStructural Members, except as otherwise shown or specified.

B. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing metal framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

C. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

D. Shaft Wall Assemblies: Provide stud shaft wall system designed and tested by manufacturer to withstand lateral loading (air pressure) of 10 lbs per sq ft for maximum wall height required, and with deflection limited to 1/240 of partition height. Refer to Section 092900 - Gypsum Board for shaft wall construction.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C754 for conditions indicated.
1. Provide framing type, weight, grade and finish of materials in accordance with Manufacturer's recommendations, except where otherwise required by governing regulations and applicable standards.
2. Provide clips, fasteners, ties, reinforcing, flat strap and backing plates, stiffeners, shoes, tracks, hangers, brackets, anchors, accessories, and trim as recommended by Manufacturer for application indicated.
5. Recycled Content of Steel Products: Provide products with average recycled content of steel products such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. (MET STUD-1) Metal Studs and Runners: ASTM C645, and meeting or exceeding flexural strength, allowable bending moment, and screw pull-out of a standard 33 mil thick stud.

C. (MET STUD-2) Shaft Wall Metal Studs: ASTM C645, steel C-H, C-T or I studs hot-dipped galvanized.

D. Double-Runners: ASTM C645 slip-type head joint; inside runner with 2-inch-deep flanges, and outer runner sized to friction fit inside runner.
E. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

F. Firestop Track: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

G. Furring and Bracing Members: Provide members with protective galvanized coating, in depths as indicated.
   1. (MET FURG-1) Hat-Shaped, Rigid Furring Channels: ASTM C645; with minimum base-metal thickness of 0.033 inch.
   2. (MET FURG-2) Z-Shaped Furring: With slotted or nonslotted web; with minimum base-metal thickness of 0.027 inch.
   3. (MET FURG-3) Cold-Rolled Steel Channels: Channel bridging, furring channels, carrying channels, steel channel stiffeners and braces; with minimum base-metal thickness of 0.054 inch.
   4. (MET FURG-4) Resilient Furring Channels: Asymmetrical steel sheet members, with face attached to single flange by a slotted leg (web), designed to reduce sound transmission.

H. Galvanized Flat Strap and Backing Plate at Interior Stud Walls: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Base-Metal Thicknesses:
      a. Typical: 0.054 inch.
      b. For Heavy Equipment and Grab Bar Locations: 0.068 inch.
   2. Where Wood Backing and Blocking is Indicated: Refer to Section 061000 for wood requirements. Provide fire-resistant treatment.

2.3 SUSPENSION SYSTEMS

A. Components, General: Comply with ASTM C754 for conditions indicated.

B. Furring Channels: As specified above.

C. Tie Wire: ASTM A641, Class 1 zinc coating, soft temper, 0.0625 inch diameter wire, or double strand of 0.0475 inch diameter wire.

D. Hanger Attachment Anchors in Concrete: Fabricated from corrosion-resistant materials with holes or loops for attaching hanger wires and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E488 by a qualified independent testing agency.
   1. Cast-in-place anchor, designed for attachment to concrete forms.
   2. Postinstalled, chemical anchor.
   3. Postinstalled, expansion anchor.

E. Wire Hangers: ASTM A641, Class 1 zinc coating, soft temper, 0.162 inch diameter.

F. Rod Hangers: ASTM A510, mild carbon steel; ASTM A153, hot-dip galvanized; 0.25 inch diameter.

G. Manufactured Suspension Grid System for Ceilings and Soffits: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
   1. Products and Manufacturers:
      a. Drywall Grid Systems by Armstrong World Industries, Inc.;
      b. Drywall Grid Systems by Chicago Metallic Corporation;
      c. Drywall Suspension System by USG Corporation.
2.4 AUXILIARY MATERIALS

A. Fasteners: Galvanized steel fasteners of type, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates; and of length suitable for adequate penetration of substrate.

B. Asphalt Protection Strips: Strip of 15 lb. asphalt saturated felt at intersection of partitions and masonry walls.

C. Isolation Strip: Provide one of the following:
   1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
   2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

D. Acoustic Sealant: In accordance with Section 092900 - Gypsum Board.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
   1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:
   1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
   2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standards: ASTM C 754.
   1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
   2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
   3. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
   4. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Install bracing at terminations in assemblies.

C. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

D. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch from plane formed by faces of adjacent framing.

3.4 FRAMING INSTALLATION

A. Framing Installation, General:
   1. Partition Heights: Extend partition stud system through suspended ceilings to structural support above, except where indicated to terminate at ceiling.
      a. Provide additional bracing for partitions extending above ceiling where indicated.
      b. Continue framing around ducts penetrating partitions above ceiling.
   2. Coordinate erection of studs with installation of service utilities. Align stud web openings. Coordinate installation of bucks, anchors, blocking, electrical and mechanical work which is to be placed in or behind partition framing. Allow such items to be installed after framing is complete.
   3. Isolate stud system from transfer of structural loading to system, both horizontally and vertically. Provide slip or cushioned joints to attain lateral support and avoid axial loading.
   4. Reinforce stud partitions and provide additional metal studs as indicated and required for installation of wall cabinets, wall mounted equipment, wall mounted mechanical and electrical fixtures, accessories, shelves and shelf standards. Provide thick steel plate to span minimum of 3 studs for installation of mirrors, toilet accessories or grab bars.
   5. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
   6. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

B. Runners and Tracks: Secure runner tracks to floor and ceiling construction, and to structure above ceilings as recommended by manufacturer, with fastener spacing not to exceed 24 inches o.c.
   1. Runner Tracks: Provide continuous track sized to match studs. Align runner tracks accurately to partition layout at both floor and ceiling. Provide fasteners at corners and ends of runner tracks.
   2. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
   3. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
   4. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

C. Metal Studs: Install studs vertically at 16 inches o.c., unless otherwise indicated, and not more than 2 inches from abutting construction, each side of openings, and at corners.
   1. Install metal studs in floor and ceiling runner tracks. Secure studs to runners. Anchor light gauge screw-type partition studs to runner tracks by screwing opposite flanges top and bottom, except screw end studs to both tracks at both flanges.
   2. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
   3. Provide additional studs at exterior corners and 2 inches from inside corners, terminations of partitions, and both sides of control joints.
   4. Where partitions abut other construction, provide vertical runner track securely attached to construction.
5. Use full length studs between runner tracks.

D. Door Openings:
1. Frame door openings with vertical studs attached to each jamb of door frame.
2. Provide additional studs 2 inches from jamb studs.
3. Frame head of door with horizontal section of runner track attached to jamb studs and provide vertical studs cut to fit between head and ceiling tracks and attach to tracks.
4. Provide 3/4 inch cold-rolled steel channel stiffener at 6 inches above door head extending at least 2 stud spaces beyond jamb studs, and attach to studs.
5. Fit runners under and above openings, secure intermediate studs at spacing of wall studs. Brace stud framing system and make rigid.

E. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

F. Wall Furring Installation:
1. Erect wall furring directly attached to concrete block and concrete walls.
2. Erect furring channels horizontally or vertically as indicated. Secure in place on alternate channel flanges at maximum 24 inches on center.
3. Space furring channels maximum 24 inches on center, not more than 4 inches from floor and ceiling lines or abutting walls.
4. Erect freestanding metal stud framing by means of adjustable furring brackets in accordance with manufacturer's directions.
5. Splicing Members: Lap furring members 8 inches and runner channels 12 inches and wire-tie near each end of lap.

3.5 SHAFT WALL INSTALLATION
A. Shaft Wall Installation, General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and ASTM C 754 other than stud-spacing requirements.
1. Anchor components to comply with ratings and performance requirements, and with governing regulations.
2. Isolate shaft system from transfer of structural loading to system, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading.
3. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.

B. Supplementary Framing: Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.

C. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

D. Sprayed Fire-Resistive Materials: Coordinate gypsum board shaft system work with sprayed-on fireproofing of structure, so that both remain complete and undamaged. Patch or replace sprayed-on fireproofing removed or damaged during installation of shaft framing system.

3.6 SUSPENSION SYSTEM INSTALLATION
A. Suspended Assemblies, General: ASTM C 754.
1. Install ceiling framing independent of walls, columns, and above ceiling work.
2. Do not bridge building expansion joints with support system.
3. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet measured lengthwise on each member transversely between parallel members.

B. Hangers: Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
1. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   a. Space hanger wires 48 inches o.c. along carrying channels and within 6 inches of ends of channel run. Anchor hanger wires to supporting structure. Do not attach hangers to metal deck tabs.
2. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
3. Coordinate location of hangers with other work.
   a. Do not attach hangers to steel roof deck.
   b. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   c. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   d. Do not connect or suspend steel framing from ducts, pipes, or conduit.

C. Carrying Channels: Position channels at proper height and level, and secure with hanger wires.
1. Space main carrying channels at maximum 48 inches on center, not more than 6 inches from perimeter walls.
2. Lap splices minimum 12 inches and secure together 2 inches from each end of splice. Provide clearance between channels and abutting walls or partitions.

D. Furring Channels: Comply with Gypsum Association GA-203.
1. Place furring channels perpendicular to carrying channels at 16 inches on center not more than 6 inches from perimeter walls.
2. Lap splices minimum 8 inches and secure together one inch from each end of splice.
3. Provide clearance between furring and abutting walls or partitions. Secure furring to carrying channels with clips.
4. Frame both sides of joints with furring and other supports.
5. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Lateral Bracing: Laterally brace entire suspension system where required. Reinforce openings in ceiling suspension system which interrupt main carrying channels or furring channels, with lateral channel bracing. Extend bracing minimum 24 inches past each end of openings.

3.7 GRID SUSPENSION SYSTEM INSTALLATION

A. Suspension Grid Systems: Install in accordance with Manufacturer’s instructions.
1. Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces.
2. Install main beams and cross tees at the on center spacing required for ceiling loading, and location of in-ceiling services.
3. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
4. Provide additional bracing as required by code.

B. Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces.

C. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

END OF SECTION
SECTION 092900
GYPSUM BOARD

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Interior gypsum board (GYP BD).
   2. Acoustic insulation (INSUL-40) and sealant.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Samples: For accessories exposed to view in final installation.
   1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

1.3 QUALITY ASSURANCE
A. Pre-installation Conference: Convene a pre-installation meeting at the beginning of the project to review acoustically rated construction requirements and to coordinate penetrations.
   1. Architect, Contractor, Owner’s representative and each trade that may need to penetrate acoustically rated construction or will be involved in construction of acoustically rated partitions and related systems must attend.
   2. Review layouts and routing for potential penetrating items, discuss reducing or eliminating penetrating items by considering alternate routing, review construction requirements, details and specifications for acoustically rated construction.
   3. A follow-up meeting should be scheduled as needed.
   4. His meeting can occur in conjunction with a regular construction progress meeting.
   5. Publish meeting minutes highlighting topics discussed, actions items and decision made.
B. Mockups: Before beginning gypsum board installation scheduled to receive Level 5 Finish, install panel mockup, 48 inches wide by 96 inches tall, demonstrating at least 2 vertical and 2 horizontal joints, for Architects review of aesthetic effects workmanship.
   1. Apply or install final finish indicated, including painting, on exposed surfaces for review of mockups.
   2. Simulate finished lighting conditions for review of mockups.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE, AND HANDLING
A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage.
   1. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 PROJECT CONDITIONS
A. Environmental Limitations: Comply with ASTM C 840 requirements and recommendations of gypsum board manufacturer, for environmental conditions before, during and after application of gypsum board.
1. Cold Weather Protection: When ambient outdoor temperatures are below 55 degrees F maintain continuous, uniform, comfortable building working temperatures of not less than 55 degrees F for minimum period of 48 hours prior to, during and following application of gypsum board and joint treatment materials or bonding of adhesives.

2. Ventilation: Ventilate building spaces as required to remove water in excess of that required for drying of joint treatment material immediately after its application. Avoid drafts during dry, hot weather to prevent too rapid drying.

B. Damaged Materials: Do not install panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
   1. STC-Rated Assemblies: Indicated by design designations from GA-600, "Fire Resistance Design Manual."

C. Shaft Wall Assemblies: Provide gypsum board shaft wall system design and tested by manufacturer to withstand lateral loading (air pressure) of 10 lbs per sq ft for maximum wall height required, and with deflection limited to 1/240.
   1. Refer to Section 092216 - Non-Structural Metal Framing for shaft wall studs.

2.2 GYPSUM PANEL PRODUCTS

A. Gypsum Board Products, General: In accordance with ASTM C 1396, and other specified requirements, and as follows:
   1. Provide products that do not contain asbestos.
   3. Provide products in maximum lengths and widths available to minimize joints and to correspond with support system indicated.

B. Manufacturers:
   1. United States Gypsum.
   5. Temple-Inland.

C. (GYP BD-1) Fire-Rated Board: Type X, 5/8 inch thick.
D. (GYP BD-2) Moisture- and Mold-Resistant Board, Type X: With moisture- and mold-resistant paper surfaces and core. Provide mold and water-resistant gypsum board as required by local building code and as indicated
  1. Thickness: 5/8 inch.
  3. Products and Manufacturers:
     a. ProRoc M2Tech by CertainTeed.
     b. ToughRock Mold-Guard by Georgia-Pacific.
     c. Sheetrock Mold Tough Firecode by United States Gypsum (USG).

E. (GYP BD-21) Gypsum Shaft Liner: One inch thick shaft wall liner panel with moisture resistant paper facing. Square edges designed for installation into I, C-H, E, or H metal studs.
     c. G-P Gypsum Corp.: ToughRock Shaftliner.
  2. Acceptable Manufacturer, Moisture and Mold Resistant Paper Faced, ASTM D3273 score of 10:
     b. National Gypsum Company: Gold Bond Brand Fire-Shield Shaftliner XP.
     c. CertainTeed Corp.: M2Tech Shaftliner Type X.
  3. Acceptable Manufacturer, Glass Mat Faced, ASTM C1658:
     a. CertainTeed Corp.: GlasRock Shaftliner Type X.
     b. G-P Gypsum Co.: DensGlass Shaftliner.

F. (GYP BD-35) Abuse-Resistant Mold-Resistant Board: ASTM C1396, ASTM D3272 score of 10 and ASTM C1629 for abuse resistance, manufactured to produce greater resistance to surface abrasion and indentation than standard gypsum panels.
  1. Products:
     c. CertainTeed Corp.: AirRenew Extreme Abuse Gypsum Board.
  3. Core: 5/8 inch, Type X.

2.3 TILE BACKER BOARDS

A. General: Provide mold- and water-resistant tile backer boards specified.
  1. Mold Resistance Requirement: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
  2. Provide cementitious tile backer boards for tile installation at showers and other high-moisture areas, and as indicated on Drawings.
  3. Contractor’s Option: Provide water-resistant gypsum backing boards in lieu of cementitious backer boards for applications other than showers or high-moisture areas, and as submitted to and accepted by Architect.

B. (GYP BD-23) Cementitious Backer Board: ANSI A118.9 and ASTM C 1325, aggregated portland cement board, reinforced with imbedded glass-fiber mesh at both faces and at long edges.
  1. Core: 1/2 inch thick.
  2. Edges: Square and smooth, reinforced.
3. Manufacturers and Products:
   a. Custom Building Products; Wonderboard.
   b. USG Corporation; DUROCK Cement Board.
   c. National Gypsum Company; PermaBase Cement Board.

C. Tile Backer Board Accessories:
   1. Fasteners: As recommended by backer board manufacturer.
   2. Tile-Setting Mortar for Joint Treatment: As specified with Section 093000 - Tiling.
   3. Joint Tape: Alkali-resistant fiberglass mesh tape, 2-inches wide, or as recommended by backer
      board manufacturer.
   4. Sealants: As specified in Section 079200 - Joint Sealants.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475.

B. Corner Trim, Edge Trim, Inside Corner Trim for Abuse Resistant Gypsum Board:
   1. Provide fully bonded paper faced and joint tape backed copolymer tapered plastic trim at abuse
      resistant gypsum board.
   2. Provide corner trim as recommended by manufacturer for each condition.

C. Joint Tape:
   1. Interior Gypsum Wallboard: Paper.
   2. Tile Backing Panels: As recommended by panel manufacturer.

D. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible
   with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use
      setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim
      flanges, use setting-type taping compound.
      a. Use setting-type compound for installing paper-faced metal trim accessories.
   3. Fill Coat: For second coat, use drying-type, all-purpose compound.
   4. Finish Coat: For third coat, use drying-type, all-purpose compound.
   5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound, or
      high-build interior coating product designed for application by airless sprayer and to be used
      instead of skim coat compound to produce Level 5 finish.

2.5 ACOUSTICAL INSULATION AND SEALANT

A. (INSUL-40) Unfaced, Mineral-Wool Blanket Insulation: ASTM C 665, Type I (blankets without
   membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes
   of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
   1. Provide at interior partitions. Glass fiber insulation is not allowed at interior partitions.
   2. Density: 2.5 pcf
   3. Thickness: Same as stud depth or as indicated.
   4. Width of Batts: Center to center dimension of metal studs and full face to face at other voids.
   5. Manufacturers:
      a. Fibrex Insulations Inc.
      b. Owens Corning; SAFB-MW
      c. Roxul Inc.; AFB
      d. USG; Thermafiber.
      e. Rockwool
B. Acoustical Sealant: Provide one of the following unless otherwise required to meet requirements of referenced STC rating. Provide low emitting sealants meeting SCQAMD rules.

1. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834 and ASTM C 919 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   a. Pecora AC-20 FTR Acoustical and Insulation Sealant.
   b. United States Gypsum Co. SHEETROCK Acoustical Sealant.
   c. Hilti Incorporated CP 506 Acoustical Sealant

   a. Non-hardening polyurethane type, ASTM C920, Type M, Class 25, Grade NS: Tremco Dymeric 511; or approved equal.
   b. Non-hardening polysulphide type, ASTM C920, one-part: Pecora GC-9; or approved equal.
   c. Non-hardening silicone type, ASTM C920, Type S, Class 25, Grade NS, one-part, low modulus type: GE Silpruf, Dow Corning 790, Tremco Spectrum 1, Pecora 864, or approved equal.
   d. Fire-Rated Joint Sealant: (FRJS) as specified in Section 078443 - Joint Firestopping.

3. Provide moldable putty type products acceptable to meet or exceed STC rating at service boxes.

C. Closed-Cell Tape Sponge Neoprene: Press-on Products, No. P-8200 or P-8100, or approved equal.

D. Foam Backer Rod: Closed cell polyethylene, ASTM C962: by ITP, Nomeco, or approved equal.

2.6 ACCESSORIES

A. (GYPA) Extruded Aluminum Profile Trim, Reveals, and Moldings: Alloy 6063-T5, ASTM B 221; Finish: field-painted to match adjacent wall. Provide corrosion-resistant primer compatible with joint compound and finish materials specified.

1. Manufacturers: Provide specified products or equivalent products by one of the following:
   a. Gordon Incorporated
   b. Fry Reglet Corporation
   c. Pittcon Industries

2. Profile Schedule:
   a. (GYPA-1) Z-Reveal: No. 625-25 by Fry Reglet. Finish as selected by Architect.
   b. (GYPA-2) Reveal Trims: Profiles and sizes as shown. Finish as selected by Architect.
   c. (GYPA-3) Channel Reveal: No. CH-453 by Eagle Mouldings; No. 335 Black Duranodic finish.
   d. (GYPA-4) Reveal Wall Base: No. DRMB-625-400 by Fry Reglet. Finish as selected by Architect.

B. Fasteners and Anchorages: GA 216, type and size as recommended by wallboard manufacturer.

C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Trim Accessories: ASTM C 1047, galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
E. Control Joints: Dietrich Zinc Control Joint No. 093

F. Joint Treatment: USG Perf-A-Tape joint system.

G. Adhesive: USG Durabond, as recommended by wallboard manufacturer for wood framing.

H. Laminating Adhesive: Joint compound or adhesive as recommended by wallboard manufacturer for laminating gypsum board face layer to gypsum board base layer.

I. Joint Sealant: As specified in Section 079000 - Joint Protection.

PART 3 EXECUTION

3.1 GYPSUM BOARD INSTALLATION

A. Install and finish gypsum board and accessories in accordance with manufacturer's printed instructions and comply with recommendations of GA 216 and ASTM C840, including appendices. Verify control joint locations at walls and ceilings with Architect.

B. Minimize butt joints by using gypsum board of maximum length possible. If cut butt joints are unavoidable, locate end butt joints as far from center of walls or ceilings as possible and stagger not less than 12 inches in alternate courses of board.

C. Do not install imperfect, damaged, damp or wet gypsum board.

D. Butt boards together for light contact at edges or ends with not more than 1/16 inch open space between boards. Do not force into place.

E. Locate edges and joints over supports or back-blocking except in horizontal applications. Position gypsum board so that both tapered edge joints and cut edges abut. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partition/walls.
   1. Form curved surfaces by carefully bending and fastening board to smooth even curve, free of flat or distorted areas and other imperfections. Comply with manufacturer's instructions for dampening of sheets or scoring of back face, if required to form to radius shown.
   2. Hold gypsum board 1/4 inch above floor at each type of partition.

F. Install solid and semisolid drywall partitions made-up of coreboard or gypsum board studs with face courses of exposed gypsum board, laminated with both adhesive and screws.

G. Isolate gypsum surfaces with control joints or other stress relief where:
   1. Partition or furring abuts structural element (except floor) or dissimilar wall or ceiling.
   2. Ceiling abuts structural element, dissimilar wall or partition or other vertical penetration.
   3. Construction changes within plane of partition or ceiling.
   4. Partition or furring run exceeds 30 feet.
   5. Ceiling dimensions exceed 30 feet in either direction.
   6. Wings of "L", "U" and "T" shaped ceiling areas are joined.
   7. Expansion joints occur in exterior wall if expansion joints are not used.
   8. Where control joint is near a door opening, locate and align control joint with edge of door frame.
      a. Ceiling height door frames may be used as control joints.
      b. Where door frames are less than ceiling height, extend control joints to ceiling from both corners

H. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

I. Provide perimeter isolation where non-load-bearing partitions abut structural decks or ceilings, or vertical structural elements. Allow not less than 1/4 inch, or more than 1/2 inch gap between gypsum and structure. Finish edges of face layer with casing bead. Seal space between casing bead and structure with continuous acoustical sealant bead. Do not attach board directly to tracks.

J. Cutting, Fitting and Trimming: Accurately measure and precut gypsum drywall units prior to installation. Make cuts from face side by scoring and snapping away from face side or by sawing. Completely cut paper on back face; do not break paper by tearing. Maintain close tolerances for accurate fit at joints between sheets and at framed openings, and allow for covering of edges of cut-outs with plates and escutcheons. Cut edges smooth as required for neat and accurate fit.

K. Begin fastening from center portion of sheet and work toward edges and ends. Ensure contact of drywall with supports by applying pressure on surface adjacent to fastener being driven. Do not locate fasteners closer than 3/8 inch from edges and ends of gypsum drywall. Drive with shank approximately perpendicular to drywall surface.

L. Drive screws with power screwdriver recommended by drywall manufacturer. Do not hammer drive screws. Set screw heads slightly below surface of drywall, but do not break or strip paper face around screw. Stagger screws on edges and ends of adjacent sheets.

M. For fire-rated Walls: Fasten to metal framing and furring with screws. Comply with drywall manufacturer’s instructions and UL requirements for fastening, but do not exceed 8 inches on center at perimeter and 12 inches on center spacing at the field. Space fasteners not less than 1/4 inch from edges and ends of gypsum drywall.
   1. For Non-rated Walls: Fasten perimeter and field at 12 inches on center.
   2. For multilayer fire-rated walls: Comply with UL requirements.
   3. For Acoustical Walls: Comply with fire-rated wall UL requirements.

N. Multilayer Application on Partitions/Walls: Apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
   1. Z-Furring Members: Apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.

O. Multilayer Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.2 ACOUSTICALLY RATED PARTITIONS

A. Where acoustically rated partitions are shown, provide complete air tight, acoustical rated assembly meeting or exceeding requirements of Sound Transmission Class (STC) ratings per manufacturer’s requirements and GA 600 for sound control requirements.

B. Do not penetrate acoustically rated partitions without authorization from Architect.
C. Stagger joints between layers of gypsum board and install gypsum board to be continuous between adjacent rooms.

D. Fit gypsum board tightly around structural elements.

E. Install continuous acoustical sealant at:
   1. Entire perimeter of wall on each side of top, bottom and side of walls.
   2. Intersection at change of plane and change of material.
   3. Gaps between service outlets and gypsum board
   4. Each penetration.
   5. Structural elements.
   6. All penetrations of partition, wall, and floor construction by ductwork, conduit, piping, or structure.
   7. All termination of partitions enclosing Noise Critical Spaces to abutting construction (e.g. partitions, structure, etc.)
   8. Both sides of door frames to abutting construction where doors are scheduled to have acoustical seals.
   9. Both sides of window frames to adjacent construction.
   10. Perimeter of and penetrations through sound isolating ceilings, roof systems, and floor systems.

F. Seal entire back of service boxes.

G. Seal gaps around penetrations as follows:
   1. One inch or less gap filled tightly with batt insulation and apply sealant.
   2. One inch or greater gap fill with acoustical insulation and moldable putty.

H. Backer Rod shall be used in all joints, product to be constructed of closed cell foam, or appropriate resilient material for sealant. Dimension shall be minimum 30% greater than joint width, unless otherwise indicated on details.

3.3 INSTALLATION OF TILE BACKER BOARD

A. Comply with manufacturer's written instructions for installation and finishing.
   2. Install backerboard, leaving a 1/8-inch to 3/16-inch gap at all joints and corners. Stagger board joints with those of adjacent rows.
   3. Fasten backerboard every 8-inches o.c. along framing members.
   4. Fill gaps solid with latex Portland cement mortar and embed 2-inch alkali resistant fiberglass tape.

B. Tape joints in backer board as recommended by board manufacturer. Seal ends, cut-edges and penetrations of each piece with tile setting mortar or water-resistant adhesive, and then immediately imbed tape and level joints.

C. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.4 VAPOR RETARDER INSTALLATION

A. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated.

B. At Open Framing: Seal vertical joints in vapor retarders over framing by lapping not less than two wall studs. Fasten vapor retarders to framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches o.c.
C. Seal overlapping joints in vapor retarders with adhesives or vapor-retarder tape according to vapor-retarder manufacturer’s instructions.
   1. Seal butt joints and fastener penetrations with vapor-retarder tape.
   2. Locate all joints over framing members or other solid substrates.

D. Firmly attach vapor retarders to substrates with mechanical fasteners or adhesives as recommended by vapor-retarder manufacturer.

E. Seal end laps and terminations after each day’s work with trowelled bead of mastic. Lap sides 2-1/2 inches minimum and ends 6 inches.

F. Seal ends and edges to each other and to adjoining surfaces with uniform fillet bead of sealant. Extend vapor retarder to perimeter of windows and door frames and other items interrupting plane of membrane.
   1. Imbed vapor retarder in sealant and tape edge to window or door frame.

G. Apply heavy pressure to membrane at top and bottom terminations with back of utility knife to assure positive adhesion at edge.
   1. Roll membrane firmly and completely, immediately after each sheet is applied.

H. Lap joints on sloped substrate in direction of drainage.

I. Work out air bubbles, wrinkles, and fishmouths. Firmly press sheet into place without stretching.

J. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarder.

K. After installation protect membrane from damage.

L. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarder.

### 3.5 ACCESSORIES INSTALLATION

A. Acoustical Insulation: Install blankets in accordance with manufacturer’s printed instructions, with tight joints in blanket units. Use tape, adhesive or staples to hold blankets in place.
   1. Place acoustical insulation in partitions tight within spaces, around cut openings, behind and around electrical and mechanical items within or behind partitions and tight to items passing through partitions.

B. Drywall Sealant: Seal perimeter of sound-rated partitions by filling open space between drywall and floor or ceiling construction with continuous bead of sealant. Fill open spaces between drywall and fixtures, cabinets and other flush or penetrating items with continuous bead of sealant. Seal sides and back of electrical boxes to completely close up openings and joints. Seal perimeter of wallboard shaft wall where it abuts other work.
   1. Apply joint sealant in accordance with Section 079000 - Joint Protection.

C. Adhesive Application: Use adhesive recommended by manufacturer for type of substrate indicated. Prepare substrate and laminate wallboard in accordance with manufacturer’s printed instructions. Provide temporary fasteners or bracing as recommended until adhesive sets.

D. Reinforce external corners of drywall with metal corner bead. Securely fasten metal corner beads, edge trim casing beads and control joints.
3.6 SHAFT WALL INSTALLATION

A. Anchor and fasten materials and components to comply with ratings and performance requirements, and to comply with governing regulations.

B. Coordinate gypsum board shaft system work with sprayed-on fireproofing of structure, so that both remain complete and undamaged. Patch or replace sprayed-on fireproofing removed or damaged during installation of shaft system.

C. Seal perimeter of each section of gypsum board shaft work where it abuts other work. Install second bead of acoustical sealant in location and manner which will prevent dislocation by air pressure differential between shaft and external spaces. Seal joints and penetrations in work; comply with manufacturer's instructions.

3.7 FINISHING

A. Finish exposed drywall surfaces with joints, corners and exposed edges reinforced or trimmed and with joints, fastener heads, trim accessory flanges and surface defects filled with joint compound in accordance with drywall manufacturer's recommendations for smooth, flush surface. Form true, level or plumb lines, without joints, fastener heads, flanges of trim accessories or defects visible after application of field-applied decoration. Exposed metal trim (not filled) will not be acceptable.

B. Use joint tape to reinforce joints formed by tapered edges or butt ends of drywall units and at interior corners and angles. Set tape in joint compound and apply skim coat over tape in one application. Do not use topping or finishing compounds for setting of tapes.

C. At field-built demountable partitions, apply filament tape to joints prior to application of joint compound, leaving a tail of unfastened tape approximately 1/2 inch either at bottom of partition (to be concealed by base) or above finished ceiling.

D. Apply joint compound to joint. Apply joint compound to fill holes left from removal of screws at intermediate studs. Finish gypsum drywall thereafter, including sanding of final coat, in accordance with ASTM C840.

E. Where open spaces of more than 1/16 inch width occur between abutting drywall units, except at control joints, prefﬁll joints with joint compound and allow prefﬁll to dry before application of joint tape.

F. Finish Levels of Joints in Interior Gypsum Board Work:
   1. Level 0: No taping, ﬁnishing, or accessories required.
      a. Use above suspended ceilings and within other concealed spaces, unless assembly is ﬁre rated, sound rated, sound or smoke controlled, or unless space serves as air plenum.
   2. Level 1: At joints and interior angles embed tape in joint compound. Leave surface free of excess joint compound. Tool marks and ridges are acceptable.
   3. Level 2: At joints and interior angles embed tape in joint compound with one separate coat of joint compound applied over joints, angles, fastener heads, and accessories.
      a. Use for mold and water resistant gypsum board indicated for use as a substrate for ceramic tile.
      b. Use for gypsum board indicated for use as a substrate for wood paneling or acoustical panels.
      c. Use above suspended ceilings and within other concealed spaces if gypsum board assembly is fire rated, sound rated, sound or smoke controlled, or space serves as air plenum.
   4. Level 3: At joints and interior angles embed tape in joint compound with 2 separate coats of joint compound applied over joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges.
      a. Use where heavy grade wall covering is ﬁnal decoration.
b. Use where gypsum board is base for acoustical ceiling tile.

5. Level 4: At joints and interior angles embed tape in joint compound with 3 separate coats of joint compound applied over joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges.
   a. Use for all locations, except those indicated for other finish levels.

6. Level 5: At joints and interior angles embed tape in joint compound with 3 separate coats of joint compound applied over joints, angles, fastener heads, and accessories. Apply thin skim coat, as specified in Joint Treatment Materials Article above, to entire surface. Leave surface smooth and free of tool marks and ridges.
   a. Use where semi-gloss or gloss finish coatings are final decoration.
   b. Use for 2 story walls with direct natural day lighting (Lobbies, Entries, Rooms with large day lighting and long walls perpendicular to windows).
   c. Use at ceilings in Lobbies, assembly areas with direct natural day lighting.
   d. Use where skim coat finish is indicated.

G. Cementitious Backer Units: Finish according to manufacturer’s written instructions.

H. Glass-Mat, Water-Resistant Backing Panels: Finish according to manufacturer’s written instructions.

3.8 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION
SECTION 093000
TILING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Tile Materials.
   4. Waterproofing and Crack Isolation Membrane
   5. Tiling Accessories.

1.2 ACTION SUBMITTALS
A. Shop Drawings: Indicate tile patterns and accessory locations; width and locations of control, isolation, contraction and expansion joints in tile surface.
B. Samples: For color selection and appearance acceptance.
   1. Full-size units of each type and size of tile and for each color and finish.
   2. Grout color samples.
   3. Full-size units of each type of ceramic tile accessory (CTA). Provide linear trim and profiles, 6 inches long.

1.3 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified Installer.
B. Material Test Reports: For each tile-setting and grouting products.

1.4 CLOSEOUT SUBMITTALS
A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: Engage installer who has minimum 5 years’ experience and who has completed tile installations similar in material, design, and extent to that indicated for this Project and with record of successful in-service performance.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
D. Store liquid materials in unopened containers and protected from freezing.
E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.7 PROJECT CONDITIONS
A. Provide sufficient heat and ventilation in areas where work of this section is being performed, so as to allow ceramic tile to properly set. Take precautionary measures necessary to ensure that excessive temperature changes do not occur.
B. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 PRODUCTS

2.1 TILE MATERIALS
A. Source Limitations for Tile: Obtain tile of each type and color or finish from one source or producer, and from same production run and of consistent quality in appearance and physical properties for each contiguous area.
B. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
D. Ceramic Tile: Standard Grade complying with ANSI A137.1. All-purpose porcelain type units with manufacturer's standard back-mounting.
   1. Basis of Design: Refer to Material Schedule for product selections and product information such as colors, finishes, and accessories..
      a. (CTF) Ceramic Floor Tiles.
      b. (CTW) Ceramic Wall Tiles.
      c. (CTB) Ceramic Wall Base Tiles.
   2. Tile Trim and Special Shapes: Rounded external corners and trim shapes at head, jamb and sills of openings.
   3. Slip-Resistant Units: Abrasive-surfaced tile with aluminum oxide abrasive uniformly distributed on face of tile to achieve minimum coefficient of friction of 0.60, ASTM C1028. Provide where indicated.

2.2 SETTING MATERIALS
A. Tile-Setting System Manufacturer: Provide complete tile-setting system consisting of materials by a single Manufacturer. Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer. Provide tile setting system by one of the following:
   1. Bostik.
   2. Custom Building Products.
   3. LATICRETE International Inc..
   4. MAPEI Corporation.
B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.

   1. Cleavage Membrane: Asphalt felt, ASTM D 226, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils thick.
   2. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A 185 and ASTM A 82 except for minimum wire size.
   3. Latex Additive: Manufacturer’s standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.

D. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4, consisting of the following:
   1. Prepackaged dry-mortar mix containing dry, redispersible, ethylene vinyl acetate additive to which only water must be added at Project site.
   2. Prepackaged dry-mortar mix combined with styrene-butadiene-rubber liquid-latex additive.
      a. For wall applications, provide nonsagging mortar that complies with Paragraph F-4.6.1 in addition to the other requirements in ANSI A118.4.
   3. Flexible Latex-Cement Mortar: Add flexible latex additive to dry mortar mix as recommended by porcelain tile manufacturer.

E. Polymer-Modified Cement Grout: ANSI A118.7. Provide Either ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients; or acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix. Color as indicated.
   1. Color: As selected by Architect from manufacturer’s full range to match tile.

F. Epoxy Grout: Chemical-resistant, water-cleanable, tile setting and grouting epoxy, ANSI A118.3.
   2. Provide at quarry tile (QT) and (QTB) installations.

G. Grout Sealer: Provide grout sealer compatible with grout materials as recommended by grout manufacturer, that does not change color or appearance of grout.
   1. Provide at quarry tile (QT) and (QTB) installations.

2.3 ACCESSORIES
A. (CTA) Ceramic Tile Metal Trim and Transition Strips:

B. (CTA-10) Fluid-Applied Waterproofing and Crack Isolation Membrane System: Provide continuous and seamless waterproofing and crack isolation system, including premixed or single-component self-curing liquid-latex rubber or elastomeric-polymer membrane; complying with ANSI A118.10 for waterproofing and ANSI 118.12 for crack isolation; ASTM C627 Extra Heavy Service rating; IAPMO-approved as shower pan liner; and recommended by the manufacturer for the application indicated.
   1. Products and Manufacturers:
      a. Redgard Waterproofing and Crack Prevention Membrane by Custom Building Products
   2. Pre-treat control joints and cracks in accordance with membrane manufacturer’s instructions.
   3. Provide reinforcement and accessories as recommended by manufacturer for complete system.

C. Sealant: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Section 079000 - Joint Sealants.
1. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.
3. Provide sanded elastomeric joints to match sanded grout joints.

D. Sealant and Backer Rod: As specified in Section 079000 - Joint Protection.

2.4 MIXING MORTARS AND GROUT
A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers’ written instructions.
B. Add materials, water, and additives in accurate proportions.
C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors comply with surface finish requirements in ANSI A108.01 for installations indicated.
   a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
   b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Prepare surfaces to receive tile as recommended by mortar or adhesive manufacturer; and in compliance with TCA's “Handbook for Ceramic Tile Installation”.
1. Roughen surfaces that are glossy or which have loose surface material by sanding or scarifying.
2. Remove surface material that is not compatible with adhesive.
3. Use primer when recommended by adhesive manufacturer.
4. Clean thoroughly to remove oil, dirt and dust.
B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
3.3 TILE INSTALLATION

A. Comply with TCA’s “Handbook for Ceramic Tile Installation” for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
   1. Achieve 100 percent bond in tile work. Back butter units 12 inch by 12 inch and larger.

B. Extend tile work into recesses and under equipment and fixtures, to form complete covering without interruptions. Terminate work neatly at obstructions, edges and corners without disruption of pattern or joint alignment.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Grind cut edges of tile abutting trim, finish or built-in items for straight, aligned joints.
   1. Fit tile closely to electrical outlets, piping and fixtures so that plates, collars or covers overlap tile.

D. Perimeter: Provide for expansion at perimeter with non-grouted and non-sealed perimeter expansion joint.

E. Expansion Joints: Locate expansion joints and other sealant filled joints, including control, contraction and isolation joints, where indicated, or if not indicated, at spacings and locations recommended in TCA Handbook for Ceramic Tile Installation, and approved by Architect.
   1. Width of expansion joints in tile to match width of aligned joints in substrate slab.

F. Grout Jointing Pattern: Unless otherwise shown, lay ceramic tile in grid pattern. Align joints when adjoining tiles on floor, base, walls and trim are same size. Layout tile work and center tile fields both directions in each space or on each wall area.
   1. Adjust to minimize tile cutting. Provide uniform joint width.
   2. Provide 1/8 inch wide joints.

G. Apply grout sealer as recommended by sealer and grout material manufacturers.

3.4 INSTALLED WORK

A. Clean grout and setting materials from face of tile while materials are workable. Leave tile face clean and free of foreign matter.

B. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer’s printed instructions, but not sooner than 10 days after installation.

C. Leave finished installation clean and free of cracked, chipped, broken, unbonded, or otherwise defective tile work.

D. Protect installed tile work with heavy covering during construction period to prevent damage and wear. Setting materials for large format tile require longer curing time.

END OF SECTION
SECTION 095100
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Acoustical panel ceilings and exposed suspension system (ACT).

1.2 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
   1. Ceiling suspension members.
   2. Method of attaching hangers to building structure.
   3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
   1. Acoustical Panel: Set of manufacturers standard size samples of each type, color, pattern, and texture.
   2. Exposed Suspension System Members, Moldings, and Trim: Set of 12 inch long samples of each type, finish, and color.

1.3 QUALITY ASSURANCE
A. Ceilings and Interior Systems Contractors Association (CISCA): Acoustical Ceilings, Use and Practice.
B. Installer's Qualifications: Firm experienced in application or installation of systems similar in complexity to those required for this Project, including specific requirements indicated.
   1. Acceptable to or licensed by manufacturer
C. Coordination of Work: Coordinate layout and installation of acoustical ceiling units and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components and partition system.
D. Source Limitations for Ceiling Units and Suspension Systems: Obtain each acoustical ceiling panel and suspension system from one source with resources to provide products of consistent quality in appearance and physical properties without delaying Work.

1.4 DELIVERY, STORAGE, AND HANDLING
A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.5 ENVIRONMENTAL CONDITIONS
A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
   1. Install ceiling tile after carpeting and other interior materials that off-gas has been installed and odors and VOC fumes have dissipated.
   2. Permit wet work to dry prior to commencement of installation.
B. Maintain uniform temperatures of minimum 60 degrees F and humidity as recommended by acoustical ceiling manufacturer prior to, during and after installation.

1.6 COORDINATION
A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.7 EXTRA MATERIALS
A. Provide extra one percent of each type of acoustical ceiling unit to Owner for replacement.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS
A. Products and Manufacturers: Provide specified Basis of Design or approved equivalent product by one of the following:
   1. Armstrong World Industries, Inc..
   2. USG Interiors, Inc..
   3. Chicago Metallic Corporation.
B. (ACT) Basis-of-Design Acoustic Ceiling Panel and Suspension Grids: As indicated on the Material Schedule.

2.2 SUSPENSION SYSTEM
A. Metal Suspension System: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
   1. Provide manufacturer’s standard aluminum grid system where indicated on Room Finish Schedule.
   2. High-Humidity Finish: Comply with ASTM C 635 requirements for “Coating Classification for Severe Environment Performance” where high-humidity finishes are indicated.
   3. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.
   4. Double-Web, Exposed Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation, with prefinished metal caps on flanges.
b. Face Design: Flat, flush.
c. Cap Material: Steel cold-rolled sheet.
d. Face Width: As indicated on Material Identification list.

5. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least three design load, but not less than 12 gauge.

B. Accessories: Provide stabilizer bars, furring clips, splices, edge moldings and hold down clips as required to complete and complement suspended ceiling grid system.
2. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.
3. Edge Moldings and Trim: Provide Roll-formed sheet metal type in profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations, formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners, and complying with seismic design requirements.
4. Touch-up Paint: Manufacturer’s touch-up paint for field cut tegular or other reveal edge tiles.

C. Carrying Channels and Hangers: Primed steel, size and type to suit application and to rigidly secure complete acoustic unit ceiling system, with maximum deflection of 1/360.

D. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

2.3 METAL EDGE MOLDINGS AND TRIM
A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
1. Provide manufacturer's edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.4 ACOUSTICAL CEILING PANELS
A. Acoustical Panel Standard: Provide manufacturer’s standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance, unless otherwise indicated.
1. Recycled Content: Provide acoustical panels with recycled content such that postconsumer recycled content plus one-half of pre-consumer recycled content constitutes a minimum of 40 percent by weight.
2. Surface-Burning Characteristics: Provide acoustical panels with surface-burning characteristics complying with ASTM E 1264 for Class A materials with flame spread of 0-25, as determined by testing identical products per ASTM E 84.

B. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
PART 3 EXECUTION

3.1 EXAMINATION
A. Examine substrates and structural framing to which ceiling system attaches or abuts, with Installer present, for compliance with requirements specified in this and other sections that affect installation and anchorage of ceiling system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half-width units at borders, and comply with reflected ceiling plans.

3.3 INSTALLATION
A. General: Install acoustical panel ceilings to comply with ASTM C636 and seismic requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
B. Suspend ceiling hangers from building's structural members and as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
   2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
   4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
   5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
   6. Do not attach hangers to steel deck tabs.
   7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
      a. Provide alternate framing method if structural members are spaced too far apart.
   8. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
   1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
   2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
   3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
D. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
E. Tolerances: Erect ceiling system level within 1/8 inch in 12'-0" in any direction.

3.4 ACoustical Panel Installation

A. Fit acoustic lay-in panels in place, free from damaged edges or other defects detrimental to appearance and function. Lay directional patterned tile one way with pattern parallel to shortest room axis.
   1. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
   2. Field recess units with tegular or reveal edge at border or ceiling edge.
   3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

B. Install lay-in panels level, in uniform plane and free from twist, warp and dents with straight joints, edges in alignment, and edges and corners flush.

3.5 Adjust and Clean

A. Adjust sags or twists that develop in ceiling systems and replace part which is damaged or faulty.

B. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage.
   1. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION
SECTION 095820
LINEAR METAL CEILINGS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Suspended linear metal beam and baffle ceiling systems (BMC-1)
   2. Sound insulation and accessories.
   3. Ceiling suspension system, hangers and inserts.
   4. Metal closures, filler strips, and end plugs.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Samples: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:
   1. Linear Metal Ceiling: Set of 12-inch- long Samples of each type and color and a 12-inch- long spliced section.
   2. Suspension System Members: 12-inch- long Sample of each type.
   3. Exposed Molding and Trim: Set of 12-inch- long Samples of each type, finish, and color.
C. Delegated-Design Submittal: For design of attachment devices.

1.3 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Linear pattern.
   2. Staggered joint pattern.
   3. Ceiling suspension members and clips.
   4. Method of attaching hangers to building structure.
   5. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
   6. Ceiling perimeter and penetrations through ceiling; trim and moldings.
B. Evaluation Reports: For linear metal ceiling and components and anchor and fastener type.

1.4 QUALITY ASSURANCE
A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Deliver linear metal pans, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
B. Handle linear metal pans, suspension system components, and accessories carefully to avoid damaging units and finishes in any way.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install linear metal ceilings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design attachment devices.
   1. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
   2. Smoke-Developed Index: 50 or less.

2.2 SUSPENDED LINEAR BEAM AND BAFFLE CEILING

A. (BMC-1) Suspended Linear Beam and Baffle Ceiling System: ASTM E 1264, formed aluminum pans and suspension system.
   1. Basis of Design: Tavola Prime Beam and Baffle System by Hunter Douglas Architectural Products, Inc..

B. Configuration:
   1. Pan Face Width: 2 inches.
   2. Pan Depth: 8 inches.
   3. Edges: Square.
   6. Provide filler strips and end caps matching pan face finish.

2.3 CEILING SYSTEM COMPONENTS

A. Edge Moldings and Trim: Provide exposed members as indicated or required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of penetrations through ceiling, to conceal ends of pans and carriers, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching linear metal pans or extruded plastic unless otherwise indicated.

B. Metal Suspension System: Provide ceiling manufacturer's standard metal suspension systems of types and finishes indicated that comply with applicable ASTM C 635 requirements.
   1. Provide systems complete with carriers, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, fixture adapters, and other suspension components required to support ceiling units and other ceiling-supported construction.
   2. Finish: All suspension components painted black.
3. Accessories: Provide stabilizer bars, furring clips, splices, edge moldings and hold down clips as required to complete and complement suspended ceiling grid system.

4. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least time three design load, but not less than 12 gauge.

5. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.

6. Edge Moldings and Trim: Provide Roll-formed sheet metal type in profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations, formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners, and complying with seismic design requirements.

7. Carrying Channels and Hangers: Primed steel, size and type to suit application and to rigidly secure complete acoustic unit ceiling system, with maximum deflection of 1/360.

C. Mechanical Fasteners and Anchors: Use material, type, size and finish required for each substrate for secure anchorage and as recommended by architectural woodwork fabricator and installer.

1. Provide concealed anchors unless otherwise indicated.

2. Provide metal expansion sleeves or expansion bolts for post-installed anchors.

3. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Examine substrates, areas, and conditions, including structural framing and substrates to which linear metal ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of linear metal ceilings.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation: Measure each ceiling area and establish layout of linear metal pans to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width pans at borders, and comply with layout shown on reflected ceiling plans and on Coordination Drawings.

C. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product.

1. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication.

2. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

3. Verify space requirements and dimensions of items shown diagrammatically on Drawings.

3.2 INSTALLATION, GENERAL

A. Comply with ASTM C 636, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspended Installation: Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.

2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate to which hangers are attached and for type of hanger involved.

5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

8. Do not attach hangers to steel deck tabs.

9. Do not attach hangers to steel roof deck. Attach hangers to structural members.

10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.

11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Install edge moldings and trim of type indicated at perimeter of linear metal ceiling area and where necessary to conceal edges and ends of linear metal pans.

1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.

2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

D. Install suspension system carriers so they are aligned and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

3.3 LINEAR METAL BAFFLE CEILING INSTALLATION

A. Suspension Components:

1. Main Runners: Install 48 inches on center by direct suspension from existing structure, with not less than 12 gauge hanger wires wrapped tightly 3 full turns, spaced 48 inches on center along component length.

2. Web Covers: Installed on main runners during main runner installation.

3. Cross Tees: Installed perpendicular to main runners 48 inches on center forming 48x48 inch modules.

4. Wall Angles: Installed on vertical surfaces intersecting suspension system by appropriate method in accordance with industry accepted practice.

B. Linear Baffle Panels and Accessories: Install perpendicular or diagonally to main runner component spaced as noted on project drawings, or identical to the baffle panel depth. 6 inch maximum allowable overhang for baffle panels. Attach with suspension clips to main runners. Connect with top alignment clip and bottom alignment sleeve.

3.4 INSTALLED WORK

A. Damaged or Non-Compliant Work: Remove and replace materials that are damaged or do not comply with requirements.

1. Damaged woodwork may be repaired or refinished if resulting repair work complies with requirements and shows no evidence of repair or refinishing.
2. Remove and replace woodwork materials that are wet, moisture damaged, or mold damaged.
3. Replace, at no additional cost to Owner, materials that are damaged or that cannot be cleaned
to satisfaction of Owner.

B. Adjusting: Adjust movable components of assembly to operate safely, smoothly, easily, and quietly,
free from binding, warp, distortion, nonalignment, misplacement, disruption, or malfunction,
throughout entire operational range, and without binding or damaging assembly components. Lubri-
cate hardware and moving parts. Adjust joinery for uniform appearance.

C. Cleaning: Clean and provide maintenance on completed construction as frequently as necessary
through the remainder of the construction period.
   1. Clean interior finish carpentry on exposed and semi-exposed surfaces. Restore damaged or
soiled areas and touch up factory-applied finishes, if any.
   2. Clean cabinetwork, counters, shelves, hardware, fittings and fixtures.

D. Protection: Provide final protection and maintain conditions that ensure installed Work is without
damage or deterioration at time of Substantial Completion.
   1. Comply with specified requirements for temperature and relative humidity.
   2. Protect installed products from damage from weather, moisture, dust, dirt and other causes
during construction.

E. Demonstration and Training: Instruct Owner's personnel to operate, adjust and maintain operable
components of assemblies.

END OF SECTION
SECTION 096001
FLOORING TRANSITION STRIPS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Transition strips (TRS).

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Samples for Initial Selection: For each type of transition strip indicated.
C. Product Schedule & Layout: Use same designations indicated on Drawings.

1.3 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Resilient Transition Strips: Furnish not less than 10 percent of total length installed, for each profile type and color.

1.4 COORDINATION & FIELD CONDITIONS
A. Coordinate installation of floor transitions strips with installation of associated floor finishes. Install flooring after other finishing operations, including painting, have been completed. Close spaces to traffic during installation.

PART 2 PRODUCTS

2.1 FLOORING TRANSITION STRIPS

2.2 INSTALLATION MATERIALS
A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland-cement-based or blended hydraulic-cement-based formulation provided or approved by flooring manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by product manufacturers to suit flooring and substrate conditions indicated.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient sheet flooring.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

END OF SECTION
SECTION 096400
WOOD FLOORING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   2. (WDF-2) Vinyl Sheet Flooring Over Subfloor.
   4. (WDF-20) Hardwood Strip Flooring Over Underlayment.
   5. Subfloor components.

1.2 ACTION SUBMITTALS
A. Product Data: For each material and floor system component.
B. Shop Drawings: For each type of floor assembly and accessory. Include plans, sections, and attachment details. Include expansion provisions and trim details.
C. Samples: Coordinate with Section 064000 for submittal of samples for concurrent review of materials by Architect.
   1. (WDF-2) Flooring System Cutaway Samples: Approximately 18 inches square; including all subfloor components.
   2. (WDF-20) Flooring System Cutaway Samples: Approximately 18 inches square, constructed of hardwood strips of specified type, thickness, width and finish, demonstrating the full range of expected color and texture variations; including all subfloor components.

1.3 INFORMATIONAL SUBMITTALS
A. Site Conditions Reports: Relative humidity and temperature readings taken before, during and after installation. Include readings taken in areas where woodwork is stored on site prior to installation.

1.4 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Hardwood Strips: Equal to 2 percent of amount installed for each type, color, and finish of wood flooring indicated.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: An experienced Installer who has completed wood flooring installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in installations with a record of successful in-service performance.
B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
   1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
1.6 FIELD CONDITIONS

A. Delivery, Handling and Storage: Protect woodwork items from damage, dust and dirt. Do not deliver, receive, store or install woodwork materials until storage and installation areas are conditioned in accordance with requirements and recommendations of NAAWS.

B. Environmental Requirements: Use permanent HVAC system or provide temporary systems and controls to establish and maintain site conditions complying with specified requirements.
   1. Do not deliver, receive, store or install architectural woodwork until building is enclosed, wet work is complete, and temporary or permanent HVAC systems are operating in areas where woodwork is stored and installed and are maintaining temperature and relative humidity at occupancy levels and within the following ranges during the remainder of the construction phase:
      a. Temperature Range: Between 60 and 90 deg F.
      b. Relative Humidity Range: Between 45 and 55 percent.
   2. Fluctuation of Temperature and Relative Humidity Levels:
      a. Do not exceed 15 percent fluctuation over any portion of a 7-day period and not to exceed 25 percent fluctuation over any portion of a 28-day period.
      b. Maintain operation and control of heating, cooling, humidity, ventilation, temporary barriers and similar facilities continuously on a 24-hour basis to avoid rapidly fluctuating ambient levels.
   3. Site Conditions Report: Monitor temperature and relative humidity in areas where woodwork is stored and installed at Project site. Record temperature and relative humidity prior to delivery, throughout storage period and installation, and after installation until time of Substantial Completion. Report recorded values in accordance with Submittals requirements.

PART 2 PRODUCTS

2.1 WOOD FLOORING, GENERAL

A. Source Limitations: For wood flooring, obtain each species, grade, and cut of wood from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

B. Hardwood Flooring: Comply with NWFA A500 for species, grade, and cut.

2.2 FLOORING SYSTEM CONFIGURATIONS

A. Floor assembly configurations as shown on Drawings and as described below:

B. (WDF-1) Hardboard Panel Flooring Over Subfloor:
   1. Tempered hardboard, 1/4-inch, 1 layer, painted finish (PT-3).
   2. T&G plywood, 3/4-inch, 1 layer.
   3. Square edge plywood, 3/4-inch, 1 layer.
   4. Wood sleepers, solid 2 by 4 lumber.
   5. Resilient isolation pads.
   6. Vapor barrier.

C. (WDF-2) Vinyl Sheet Flooring Over Subfloor:
   1. Vinyl sheet flooring, 1.2 mm.
   2. Tempered hardboard, 1/4-inch, 1 layer.
   3. T&G plywood, 3/4-inch, 1 layer.
   4. Square edge plywood, 3/4-inch, 1 layer.
   5. Wood sleepers, solid 2 by 4 lumber.
   7. Vapor barrier.
D. (WDF-3) Hardboard Panel Flooring Over Subfloor:
   1. Tempered hardboard, 1/4-inch, 1 layer, painted finish (PT-3).
   2. T&G plywood, 3/4-inch, 1 layer.
   3. Square edge plywood, 3/4-inch, 1 layer.
   4. Wood sleepers, solid 2 by 4 lumber.
   5. Resilient isolation pads.

E. (WDF-20) Hardwood Strip Flooring Over Underlayment:
   1. Solid rift sawn red oak strips, end-matched, blind-nailed.
   2. T&G plywood, 3/4-inch, 1 layer.
   3. Vapor barrier.

2.3 FLOORING SYSTEM COMPONENTS

A. Solid-Wood Hardwood: Kiln dried to 6 to 9 percent maximum moisture content, tongue and groove and end matched, and with backs channeled (kerfed) for stress relief.
   1. Species, Cut & Finish: Red Oak, rift sawn, stain and transparent finish to match WD-1 as specified in Section 064000.
   2. Edge Profile: Tongue and groove.
   3. Face Width: 2-1/4 inches.
   5. Lengths: Random-length strips complying with applicable grading rules.
   6. Finish: Stain and waterborne urethane finish system as specified below.

B. Field-Applied Transparent Finish System: Complete water-based system of compatible components that is recommended by finish manufacturer for application indicated, and matching Architect's sample.
   1. Wood Filler: Compatible with finish system components and recommended by filler and finish manufacturers for use indicated. If required to match approved Samples, provide pigmented filler.
   2. First Coat, Stain: Deep penetrating, low VOC, one-coat, UV stable stain.
      b. Color: Cinnamon.
      a. Product: Sansin Purity Floor.
      a. Product: Sansin Purity Floor.

C. Sheet Vinyl Flooring:

D. Painted Finishes: In compliance with Section 099000 - Painting, and as follows:

E. Hardboard Panel: 1/4-inch tempered S2S hardboard.

F. Plywood for Subfloor:
   1. Tongue and Groove Edge: Group 1, EXT-APA B-B, with special solid jointed core construction (B-Grade); installed with staggered joints.
   2. Square Edge: C-D EXT, thickness as indicated, installed with staggered joints.

G. Slip Sheet: Red-rosin type building paper, 3 lb/100 sq. ft. minimum weight.

I. Neoprene Waffle Pads: Natural rubber resilient pads. Isolation Pad Deflection: Provide pad spacing and durometer such that manufacturer’s recommended deflection is not exceeded under normal and maximum anticipated loads. Pad spacing shall be at least 16” o.c., but no farther than 24” o.c..
   1. Durometer: 50 as required.
   2. Size: 2 inches by 2 inches.
   3. Thickness: 3/4-inch.
   4. Basis of Design: Super W Pads by Mason Industries

J. Vapor Retarder: ASTM D4397, polyethylene sheet not less than 6.0 mils thick.

2.4 INSTALLATION ACCESSORIES


B. Fasteners: As recommended by manufacturer, but not less than that recommended in NWFA’s "Installation Guidelines: Wood Flooring."

C. Wood Flooring Adhesive: Mastic recommended by flooring and adhesive manufacturers for application indicated.
   1. Use adhesives that have a VOC content of not more than 100 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Cork Expansion Strip: Composition cork strip.

E. Solid Wood Trim, Vents and Grilles: Of same species and grade as wood flooring and in sizes indicated on Drawings.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of wood flooring.
   1. Slab Depression: Verify slab surface is level, maintaining a consistent slab depression of 2-3/4 inches measured from surface of adjacent terrazzo.
   2. Grind high spots and fill low spots to produce a maximum 1/8-inch deviation in any direction when checked with a 10-foot straight edge.
   3. Use trowel-applied leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.
   4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

C. Broom and vacuum substrates immediately prior to product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with flooring manufacturer's written installation instructions, but not less than applicable recommendations in NWFA's "Installation Guidelines."

B. Vapor Barrier: Install in accordance with vapor barrier Manufacturer’s written instructions.
C. Wood Sleepers and Subfloor: Install according to requirements in Section 061000 - Rough Carpentry.

D. Solid-Wood Flooring: Blind nail or staple flooring to substrate.

E. Provide expansion space at walls and other obstructions and terminations of flooring of not less than 3/4 inch.

3.3 FIELD FINISHING

A. Machine-sand flooring to remove offsets, ridges, cups, and sanding-machine marks that are noticeable after finishing. Vacuum and tack with a clean cloth immediately before applying finish.
   1. Comply with applicable recommendations in NWFA's "Installation Guidelines."

B. Fill open-grained hardwood and repair wood flooring defects.

C. Apply floor-finish materials in number of coats recommended by finish manufacturer for application indicated, but not less than one coat of floor sealer and three finish coats.
   1. Apply stains to achieve an even color distribution matching approved Samples.
   2. For water-based finishes, use finishing methods recommended by finish manufacturer to minimize grain raise.

D. Comply with finish Manufacturer's written instructions for covering, or leaving it exposed until cured.

E. Do not cover wood flooring after finishing until finish reaches full cure, and not before seven days after applying last finish coat.

3.4 INSTALLED WORK

A. Protect installed wood flooring during remainder of construction period with covering of heavy kraft paper or other suitable material. Do not use plastic sheet or film that might cause condensation.
   1. Do not move heavy and sharp objects directly over kraft-paper-covered wood flooring. Protect flooring with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION
SECTION 096500
RESILIENT FLOORING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
1. Resilient floor tile (RFT).
2. Resilient sheet flooring (RSF).
3. Resilient wall base (RB).
4. Installation accessories.
B. Related Sections:
1. Section 033000 - Cast-In-Place Concrete: Substrate preparation.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.

1.3 INFORMATIONAL SUBMITTALS
A. Slab Moisture Content and Calcium Chloride Test Results.
B. Compatibility Certification: Submit approval documentation by both flooring manufacturer and adhesive manufacturer as compatible with substrate, flooring, project conditions, use, expected traffic, equipment loads and surface conditions including alkalinity, moisture emission levels, slab relative humidity, and other factors that may affect flooring and adhesive performance.
C. Maintenance Instructions: Submit manufacturer's written instructions for recommended maintenance practices for each type of resilient flooring.

1.4 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. (RB-1) Resilient Base: Furnish not less than 5 percent of total linear feet installed.
2. Other Replacement Materials: Furnish not less than one percent of total project quantity of each type, size and color of material to Owner for replacement materials. Clearly identify each container of replacement materials.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor covering installation.

1.6 FIELD CONDITIONS
A. Deliver resilient flooring materials in manufacturer's protective packaging. Store and handle flooring with care to prevent damage.
B. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor coverings during the following time periods:
1. 72 hours before installation.
2. During installation.
3. 72 hours after installation.

C. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

D. Install floor coverings after other finishing operations, including painting, have been completed.

E. Close spaces to traffic during floor covering installation and for 72 hours after floor covering installation.

F. General Contractor shall be responsible for conducting one calcium chloride test for every 1,000 square feet (minimum of 3 tests) to insure concrete moisture emissions do not exceed 5.0 lbs per 1,000 square feet within a 24-hour period.

PART 2 PRODUCTS

2.1 RESILIENT PRODUCTS

A. Single Source: Provide each type of resilient flooring produced by single manufacturer, single run.

B. Basis of Design: As indicated on Material Schedule.

C. (RFT) Linoleum Floor Tile: ASTM F 2195, Type II, linoleum floor tile with special backing.


E. (RB) Rubber Wall Base: ASTM F 1861, Type TS, Group 1, Styles A and B. Provide in 120-feet long rolls. Provide standard top-set cove base, except provide straight base at carpet.
1. ASTM E 84; Class B rating with smoke density of 150-200.

F. (RTS) Resilient Floor Finish Transition Strips:

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Skim Coat: Portland cement-based, trowel-applied skim coat intended for thin application over rough or abrasive surfaces to create a smooth prepared surface to receive resilient flooring.
1. Extent: At stair treads and landings in P1, P2 and P3.
2. Primer: As recommended by and manufactured by concrete topping Manufacturer.
3. Aggregate: Well washed, graded, fine gravel or larger aggregate as recommended by Manufacturer.

C. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
1. VOC Content: Comply with the following limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   a. VCT Adhesives: Not more than 50 g/L.
   b. Cove Base Adhesives: Not more than 50 g/L.
   c. Rubber Floor Adhesives: Not more than 60 g/L.

D. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

E. Sealer and Wax: Type recommended by resilient flooring material manufacturer for material type and location.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
   1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.

B. Concrete Substrates: Prepare according to ASTM F 710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
   4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
      a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
      b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor coverings until they are same temperature as space where they are to be installed.
   1. Move floor coverings and installation materials into spaces where they will be installed at least 72 hours in advance of installation.

E. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

3.3 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.

G. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 INSTALLED WORK

A. Comply with manufacturer’s written instructions for cleaning and protection of floor coverings.

B. Perform the following operations immediately after completing floor covering installation:
   1. Remove adhesive and other blemishes from exposed surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.

C. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor coverings before applying liquid floor polish.

END OF SECTION
SECTION 096723
RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Decorative quartz resinous flooring system (PTE-20).
   2. Preparation of concrete substrate to receive resinous flooring.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product specified. Include manufacturer's technical data, installation instructions, and recommendations for each resinous flooring component required
B. Samples for Initial Selection: Submit samples representing standard color range.
C. Samples: Provide samples for each resinous flooring system required, 6 inches square, applied by Installer for this Work to a rigid backing, in color, texture, and finish indicated. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

1.3 QUALITY ASSURANCE
A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of flooring systems required for this Project.
   1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
B. Preinstallation Conference: Conduct conference at Project site.
C. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Apply full-thickness mockups on 48-inch- square floor area selected by Architect.
      a. Include 48-inch length of integral cove base with inside[ and outside] corner.
   2. Simulate finished lighting conditions for Architect's review of mockups.
   3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE, HANDLING
A. Store materials in dry, protected area with minimum temperature of 55 degrees F and away from fires or open flames.

1.5 PROJECT CONDITIONS
A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring installation.
B. Lighting: Provide uniform and sufficient lighting in areas of installation.
C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.
D. Ventilate area in which flooring is being applied as required.
1.6 COORDINATION

A. Concrete Curing: Coordinate curing methods with manufacturer’s requirements for substrate compatibility.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Source Limitations: Obtain primary elastomeric flooring materials including primers, resins, hardening agents, grouting coats, topcoats, finish and sealing coats from single manufacturer with not less than 3 years of successful experience in supplying principal materials for work of type described in this section.

1. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

B. Flammability: Self-extinguishing according to ASTM D 635.

C. Product shall withstand anticipated traffic and be VOC compliant product.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide Basis of Design or equivalent flooring system by one of the following manufacturers and as approved by Architect:

1. BASF Construction Chemicals, Inc.; BASF Building Systems.
2. Crossfield Products Corp.; Dex-O-Tex.
3. DUDICK Inc.
4. International Coatings Inc.
5. Micor Company, Inc.
6. NEOGARD; Division of JONES-BLAIR.
7. PPG Industries, Inc.
9. Sherwin-Williams Company; General Polymers.
10. Stonhard, Inc.
11. Tennant Company
12. Tnemec Company, Inc.
13. Valspar Flooring.
14. Or Approved Equal.

2.3 RESINOUS FLOORING SYSTEMS


2. Configuration:
   a. Color and Pattern: As selected by Architect from manufacturer’s full range.
   b. Wearing Surface: [Textured for slip resistance] [Orange-peel texture] [Smooth] [Manufacturer’s standard wearing surface].
   c. Overall System Thickness: [1/16 inch] [1/8 inch] [3/16 inch] [1/4 inch].
3. Primer: Type recommended by manufacturer for substrate and body coats indicated.
4. **Slurry Coat and Bonding Coat**: Self-leveling epoxy resin slurry with broadcast color quartz aggregates, spread with notched trowel or rubber squeegee.
   a. **Slurry Coat**: 1/8 inch minimum thickness.

5. **Grout and Topcoat**: High-performance, high-solids two-component epoxy finish coat.
   a. **Type**: Clear.
   b. **Finish**: Non-slip quartz aggregate finish.

6. **System Physical Properties**: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
   a. **Compressive Strength**: 12,000 psi per ASTM C579.
   b. **Tensile Strength**: 2500 psi per ASTM C307.
   c. **Flexural Modulus of Elasticity**: 4500 psi per ASTM C580.
   d. **Resistance to Elevated Temperature**: No slip or flow of more than 1/16 inch per MIL-D-3134.
   e. **Abrasion Resistance**: 70-90 maximum weight loss per ASTM D4060.
   f. **Flammability**: Self-extinguishing per ASTM D635.
   g. **Hardness**: 70/65, Shore D per ASTM D2240.
   h. **Bond Strength**: 300 psi, 100 percent concrete failure per ACI 503R.

2.4 **SUBSTRATE PREPARATION MATERIALS**

   A. **Moisture Vapor Control**: Provide Manufacturer’s moisture mitigation primer as recommended in writing by flooring system Manufacturer.

   B. **Patching and Fill Material**: Resinous product of or approved by resinous waterproof flooring manufacturer and recommended by manufacturer for application indicated.

   C. **Joint Sealant**: Provide sealant type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated, and compatible with resinous floor system.

**PART 3 - EXECUTION**

3.1 **EXAMINATION**

   A. **Ensure that subfloor is clean, dry, hard, sound, and free of oils or other substance which would affect proper bonding and curing**.

   B. **Substrate shall be above 50 degrees F, dry and free of excessive water vapor transmission with a relative humidity below 85 percent**.

   C. **Moisture Vapor Transmission**: Perform Calcium Chloride test per ASTM F1869-04 to determine moisture vapor emission levels prior to application. If results exceed 3 pounds per 1000 square feet in 24 hours, apply manufacturer’s recommended vapor control product and retest until results are within 3 pound limit. If test results exceed 15 pounds per 1000 square feet in 24 hours, consult resinous flooring manufacturer before applying vapor control products. Perform test after surface cleaning is performed. Notify Architect immediately of test results.

   D. **Verify that all floor penetrations are sealed**.

3.2 **SUBSTRATE PREPARATION**

   A. **Concrete Substrates, General**: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

   1. **Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and re-circulates the shot by vacuum pickup.**
2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written recommendations.
3. Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated.

B. Moisture Testing: Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
   1. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. of slab area in 24 hours.
   2. Perform plastic sheet test, ASTM D 4263. Proceed with application only after testing indicates absence of moisture in substrates.
   3. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

C. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

D. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

E. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

F. Keyways: Saw-cut key ways into concrete substrate in accordance with Manufacturer's written recommendations.

3.3 APPLICATION

A. General: Apply components of flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
   1. Coordinate application of components to provide optimum adhesion of resinous waterproof flooring system to substrate and optimum intercoat adhesion.
   2. Cure resinous components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
   3. At substrate expansion and isolation joints, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.
   4. Apply system with sufficient texture to slip resistance required by local code and provide surface texture to allow ease of cleaning.

B. Primer: Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Waterproofing: Apply waterproofing membrane, where indicated, in manufacturer's recommended thickness.
   1. Apply waterproofing membrane to integral cove base substrates.

D. Reinforcement: Apply reinforcing membrane to [substrate cracks] [entire substrate surface].

E. Coatings: Apply coatings in thickness indicated. When cured, sand to remove trowel marks and roughness.
2. **Troweled or Screeded Body Coats:** Apply troweled or screeded body coats in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When body coats are cured, remove trowel marks and roughness using method recommended by manufacturer.

3. **Grout Coat:** Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat.

4. **Topcoats:** Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer and to produce wearing surface indicated.

F. **Aggregates:** Broadcast aggregates at rate recommended by manufacturer and, after resin is cured, remove excess aggregates to provide surface texture indicated.

G. **Integral Cove Base:** Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.

1. Integral Cove Base Height: As shown, see Drawings.

### 3.4 FIELD QUALITY CONTROL

A. **Waterproofing:** Verify waterproof integrity of waterproof system.

1. On completion of installation of membrane, dam areas in preparation for flood testing.
2. Flood area to minimum depth of one inch with clean water. After 48 hours, check for leaks.
3. If leaking is found, patch using same waterproofing materials; repeat flood-test.
4. When area is proved watertight, drain water and remove dam.

B. **Material Sampling:** Owner may at any time and any number of times during resinous flooring application require material samples for testing for compliance with requirements.

1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

C. Prepare test and inspection reports.

### 3.5 INSTALLED WORK

A. **Protection:** Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

**END OF SECTION**
SECTION 096800
CARPETING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Carpet tiles and sheet carpet (CPT).
   2. Installation accessories.

B. Related Sections:
   1. Section 033000 - Cast-in-Place Concrete: Finish troweling of concrete floor slabs.
   2. Section 087100 - Door Hardware: Thresholds for door openings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include manufacturer's written data on physical characteristics and durability.
   2. Include manufacturer's written installation recommendations for each type of substrate.

B. Shop Drawings: For carpet installation, showing the following:
   1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts
      are required in carpet.
   2. Carpet type, color, and dye lot.
   3. Type of subfloor.
   4. Type of installation.
   5. Pattern of installation.
   6. Pattern type, location, and direction.
   7. Pile direction.
   8. Transition details to other flooring materials.

C. Samples: For each of the following products and for each color and texture required. Label each
   Sample with manufacturer's name, material description, color, pattern, and designation indicated on
   Drawings and in schedules.
   1. Carpet: 12-inch- square Sample.
   2. Carpet Tile: Full-size Sample.
   3. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.
   5. Carpet Seam: 6-inch Sample.

1.3 INFORMATIONAL SUBMITTALS

A. Compatibility Certification: Submit approval documentation by both flooring manufacturer and
   adhesive manufacturer as compatible with substrate, flooring, project conditions, use, expected
   traffic, equipment loads and surface conditions including alkalinity, moisture emission levels, slab
   relative humidity, and other factors that may affect flooring and adhesive performance.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet to include in maintenance manuals. Include the following:
   1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures
      and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to finishes and performances. Including cleaning and stain-removal products and procedures.

B. Extra Materials: Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.
   1. Carpet Tiles: Before installation begins, furnish quantity of full-size units equal to 5 percent of amount installed.

1.5 QUALITY ASSURANCE
   A. Installer Qualifications: Engage experienced Installer who is certified by Floor Covering Installation Board (FCIB) or who can demonstrate compliance with FCIB certification program requirements.

1.6 DELIVERY, STORAGE AND HANDLING
   A. Comply with the Carpet and Rug Institute’s CRI 104, Section 5: “Storage Handling.”
   B. Deliver materials to Project site in original wrappings and containers, labeled with identification of manufacturer, brand name, and lot number.
   C. Store materials on-site in original undamaged packages, inside well-ventilated area protected from weather, moisture, soilage, extreme temperatures, and humidity. Lay flat, with continuous blocking off ground.

1.7 PROJECT CONDITIONS
   A. Comply with CRI 104, Section 6: “Site Conditions.”
   B. Space Enclosures and Environmental Limitations: Do not install carpet until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.
   C. Subfloor Moisture Conditions: Moisture emission rate of not more than 3 lb/1000 sq. ft/24 hours when tested by calcium chloride moisture test in compliance with CRI 104, 6.2.1, with subfloor temperature not less than 55 degrees F.
   D. Subfloor Alkalinity Conditions: pH range of 5 to 9 when subfloor is wetted with potable water and pHdrion paper is applied.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Fire-Test-Response Characteristics: Provide carpet with following fire-test-response characteristics as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify carpet with appropriate markings of applicable testing and inspecting agency.
      2. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm per ASTM E648.
      3. Flame Spread: 25 or less per ASTM E84.
      4. Smoke Developed: 450 or less per ASTM E84.
2.2 **CARPETING**
A. Single-Source Responsibility: Obtain each type of carpet from one source and by single manufacturer.
B. (CPT) Basis of Design Carpet Tiles: As indicated on Material Schedule.

2.3 **INSTALLATION ACCESSORIES**
A. Trowel-Applied Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.
B. Concrete-Slab Primer: Non-staining type as recommended by carpet manufacturer.
C. Adhesive: Water-resistant, mildew-resistant, nonstaining type recommended and approved by flooring manufacturer to suit products and subfloor conditions indicated and to comply with flammability requirements for installed carpet as recommended by carpet manufacturer.
   1. Releasable, pressure sensitive type adhesive shall be water-based and allow for removal without damage to carpet or substrate and leave no residue.
D. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.
   1. Adhesive Seam Sealer: (For 6 foot roll goods) As required, provide adhesive seam sealer certified in writing by the manufacturer as compatible with carpet backing. Seam sealer shall have minimum five year manufacturer’s guarantee. Sealer shall create a 100% chemical weld at the seam site to provide a monolithic installation with a moisture barrier.
E. (TRS) Transition Strips: Refer to Material Identification List and to Drawings for type and color selected. Provide in profile and with finish as indicated by specified product, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 EXECUTION

3.1 **EXAMINATION**
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance.
B. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 - Cast-in-Place Concrete and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
C. Floor Substrate Criteria: Ensure concrete floors are dry and meet moisture conditions required by flooring and adhesive manufacturer’s and exhibit negative alkalinity, carbonization or dusting.
   1. Remove curing agents and other surface residue that may negatively affect adhesion or flooring installation and performance.
   2. Moisture vapor emissions do not exceed 75 percent RH when tested in accordance with ASTM F2170 unless otherwise required by finished flooring and adhesive manufacturer.
3. Moisture in concrete slab conditions up to 3lb. per 1,000 sq. ft. per 24 hours when tested with a prepackaged calcium chloride crystal kit performed in accordance with ASTM F1869 unless otherwise required by finished flooring and adhesive manufacturer.
4. Concrete slab alkalinity conditions up to a pH of 6-9 when tested in accordance with ASTM F710 with in-situ monitoring, unless otherwise required by finished flooring and adhesive manufacturer.
5. Maintain testing records and submit along with warranties for Project Record Documents.

D. Slab Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
   1. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
   2. Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
   3. Perform additional moisture tests recommended in writing by adhesive and carpet manufacturers.
   4. Proceed with installation only after substrates pass testing.

3.2 PREPARATION
A. General: Comply with CRI's "CRI Carpet Installation Standard" and with carpet manufacturer's written installation instructions for preparing substrates.
B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.
C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet manufacturers.

3.3 INSTALLATION
A. Comply with CRI's "CRI Carpet Installation Standard" and written installation instructions by carpet and adhesive manufacturers.
   1. Installation Method: Glue-down method as recommended in writing by carpet manufacturer
   2. Maintain dye-lot integrity. Do not mix dye lots in same area.
   3. Install pattern parallel to walls and borders.
B. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
C. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

3.4 INSTALLED WORK
A. Cleaning: Perform the following operations immediately after installing carpet:
   1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
2. Remove yarns that protrude from carpet surface.

B. Protection: Protect installed carpet to comply with CRI's "CRI Carpet Installation Standard."

END OF SECTION
SECTION 097700
FIBERGLASS-REINFORCED PANELS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Fiberglass-reinforced plastic panels and accessories (FRP-1).

1.2 SUBMITTALS
A. Product Data: For each type of fiberglass-reinforced panel indicated,
   1. Include installation instructions, construction details, weights, individual components, profiles and finishes.
B. Samples: Two 8 inch by 10 inch samples of each type of panel, 10 inch length of each type of trim and molding, fastener.
C. Shop Drawings: Indicate and dimension locations of joints, fastener attachments.
   1. Show fabrication and installation details not shown on product data.
   2. Show profiles, thicknesses, joints, tolerances and anchorage details.
   3. Show connections to wall mounted items: cutouts for grilles.

1.3 QUALITY ASSURANCE
A. Installer Qualifications: An experienced installer who has completed fiber glass-reinforced panel installations similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

1.4 PROJECT CONDITIONS
A. During installation and for not less than 48 hours before, maintain ambient temperature and relative humidity within limits required by type of adhesive used.
B. Allow no containers of adhesive to be opened until potential sources of flame or spark have been shut down or extinguished and until warnings against their ignition during adhesive application have been posted.
C. Provide ventilation to disperse fumes during application of solvent-based adhesive.
D. Field Measurements: Where fiber glass-reinforced panels are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating products without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.5 COORDINATION
A. Coordinate layout and installation of fiber glass-reinforced panels and attachment system components with other construction, including partition assemblies.
PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test Response Characteristics: Provide fiber glass-reinforced panels with the following surface-burning characteristics as determined by testing identical products per ASTM E84 by UL or another independent testing and inspecting agency acceptable to authorities having jurisdiction:
   1. Flame Spread: 25 or less.
   2. Smoke Developed: 450 or less.

2.2 FIBERGLASS-REINFORCED PLASTIC PANELS

A. Products and Manufacturers: Provide Basis of Design or equivalent product by one of the following manufacturers:
   1. Glasbord with Surfaseal by Crane Composites.
   2. Structoglas by Crane Composites.
   3. Marlite FRP by Marlite.
   4. Fiber-Lite by Nudo Products, Inc.

   1. Nominal Thickness: 0.090 inch.
   2. Panel Finish: Smooth or Embossed (Pebble Texture) as selected by Architect.

2.3 ACCESSORIES

A. Trim Accessories: Manufacturer's standard two-piece, snap-on vinyl extrusions designed to cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.

B. Adhesive: As recommended by panel manufacturer for application to substrate.
   1. VOC Content: 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Sealant: Single-component, mildew-resistant silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 079000 - Joint Protection.
   1. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Exposed Fasteners: Non-corrosive nylon drive rivets as recommended by panel manufacturer.

E. Concealed Mounting Splines: Continuous, H-shaped aluminum extrusions designed to fit into grooves routed in edges of factory-laminated panels and to be fastened to substrate.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Examine back-up surfaces to determine that corners are plumb and straight, surfaces are smooth, uniform, clean and free from foreign matter, nails countersunk, joints and cracks filled flush and smooth with adjoining surface.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Preparation for Adhesive Application:
   1. Remove wallpaper, vinyl wall covering, loose or soluble paint, and other materials that might interfere with adhesive bond.
   2. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.
   3. Clean substrates of substances that could impair bond of adhesive, including oil, grease, dirt, and dust.

B. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.

C. Lay out paneling before installing. Locate panel joints to provide equal panels at ends of walls not less than half the width of full panels and so that trimmed panels at corners are not less than 12 inches wide, or as shown on Drawings.
   1. Mark plumb lines on substrate at trim accessory and panel joint locations for accurate installation.
   2. Locate trim accessories and panel joints to allow clearance at panel edges according to manufacturer's written instructions.

3.3 INSTALLATION

A. Install fiberglass-reinforced paneling according to manufacturer's written instructions.

B. Install panels in a full spread of adhesive.

C. Install panels with fasteners. Layout fastener locations and mark on face of panels so that fasteners are accurately aligned.
   1. Drill oversized fastener holes in panels and center fasteners in holes.
   2. Apply sealant to fastener holes before installing fasteners.

D. Install trim accessories with [adhesive] [and] [nails].

E. Fill grooves in trim accessories with sealant before installing panels and bed inside corner trim in a bead of sealant.

F. Maintain uniform space between panels and wall fixtures. Fill space with sealant.

G. Maintain uniform space between adjacent panels and between panels and floors, ceilings, and fixtures. Fill space with sealant.

H. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION
SECTION 098000
ACOUSTIC SURFACE TREATMENTS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
1. Fabric-wrapped acoustic panels (AST-1).
2. Copolymer-faced acoustic panels (AST-2).
3. Surface-applied sound-absorbing insulation panel (AST-10).

1.2 ACTION SUBMITTALS
A. Product Data: For each type of fabric facing, panel edge, core material, and mounting indicated.
B. Shop Drawings: Include mounting devices and details; details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge and core materials.
   1. Layout include elevations showing panel sizes and direction of fabric weave and pattern matching.
C. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Electrical outlets, switches, and thermostats.
   2. Items penetrating or covered by sound-absorbing panels.
   3. Suspended ceiling components above ceiling units.
   4. Structural members to which suspension devices will be attached.
D. Samples:
   1. Assembled Fabric-Wrapped Panels (AST-1) and (AST-2): Submit two assembled panels for each AST type, approximately 12 by 12 inches, including panel core, edges, fabric facing and mounting hardware.
   2. Assembled Fabric-Wrapped Panels (AST-1) and (AST-2): Submit two assembled panels for each AST type, approximately 12 by 12 inches, including panel core, edges, fabric facing and mounting hardware.
   3. Direct-Applied Insulation (AST-10): Submit two samples, 12 inches by 12 inches.
   4. Wood Panel (AST-20)

2.1 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer.
B. Field Test Reports: For Adhesion and compatibility testing.
C. Product Certificates: For each type of sound-absorbing wall unit, from manufacturer.

2.2 CLOSEOUT SUBMITTALS
A. Maintenance Data: For each product.
B. Maintenance Material Submittals: Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fabric: For each fabric, color, and pattern installed, provide length equal to 5 percent of amount installed, full width of bolt.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by Manufacturer of acoustic treatment.

B. Mockups: Before installing acoustical wall panels, build mock-ups for each form of construction and finish required to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.
   1. Build mockup of two (AST-1), minimum 48 inches by full width of space between precast concrete T’s, installed in-place as shown on Drawings.
   2. Obtain Architect’s approval of mock-ups before starting acoustical wall panel fabrication.

C. Preconstruction Adhesion and Compatibility Testing:
   1. Bond Strength: Test for cohesive and adhesive strength according to ASTM E 736.
   2. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   3. For materials failing tests, obtain manufacturer’s written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.4 FIELD CONDITIONS

A. Delivery, Storage and Handling: Do not deliver or install acoustic treatments until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Site Requirements:
   1. Condition spaces and surfaces receiving insulation in accordance with Manufacturer’s written recommendations
   2. Protect absorptive acoustic treatments from exposure to airborne odors, such as tobacco smoke, and install under conditions free from odor contamination of ambient air.

C. Wood Diffusor Panels: Do not deliver, receive, store or install until building is enclosed, wet work is complete, and temporary or permanent HVAC systems are operating in areas where woodwork is stored and installed and are maintaining temperature and relative humidity at occupancy levels and within the following ranges during the remainder of the construction phase:
   1. Temperature Range: Between 60 and 90 deg F.
   2. Relative Humidity Range: Between 25 and 55 percent.
   3. Fluctuation of Temperature and Relative Humidity Levels:
      a. Do not exceed 15 percent fluctuation over any portion of a 7-day period and not to exceed 25 percent fluctuation over any portion of a 28-day period.
      b. Maintain operation and control of heating, cooling, humidity, ventilation, temporary barriers and similar facilities continuously on a 24-hour basis to avoid rapidly fluctuating ambient levels.

D. Field Measurements: Verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings.

1.5 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to the following:
   b. Fabric sagging, distorting, or releasing from edges.
   c. Warping of core.

2. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Provide sound-absorbing wall units meeting the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. Surface-Burning Characteristics: As determined by testing per ASTM E 84.
   2. Flame-Spread Index: 25 or less.
   3. Smoke-Developed Index: 450 or less.
   4. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265.

2.2 FABRIC-WRAPPED PANELS

A. Manufacturers: Subject to compliance with requirements, provide Basis of Design or equivalent product by one of the following manufacturers:
   1. Capaul
   2. Conwed Designscapes.
   3. Decoustics Limited.
   5. RPG Inc.
   6. Wall Technology, Inc.

B. (AST-1) Fabric-Wrapped Wall Panels: Fixed panels consisting of acoustically-transparent fabric facing stretched over sound-absorbing core panel.
   3. Fabric Facing: As indicated on Material Schedule.
   4. Core: Glass-fiber board, ASTM C 612, of type standard with manufacturer, nominal density of 6 to 7 lb/cu. ft.
   5. Attachment: Back-mounted with manufacturer's metal clips or bar hangers.

C. Fabrication: Use manufacturer's standard construction except as otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.
   1. Edge Construction: Manufacturer's standard chemically hardened core with no frame.
   2. Edge Profile: Square.
   3. Corner Detail in Elevation: Square with continuous edge profile indicated.
   4. Panel Width and Height: As indicated on Drawings.
   5. Fabric Facing: Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.
      a. Square Corners: Tailor corners.
      b. Radius and Other Nonsquare Corners: Attach facing material so there are no seams or gathering of material.
c. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent units.

6. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for thickness, edge straightness, overall length and width, and squareness from corner to corner.

2.3 COPOLYMER-FACED PANELS

A. (AST-2a) and (AST-2b) Perforated Copolymer-Faced Panel: Fixed panels consisting of acoustically-transparent fabric facing heat-formed over sound-absorbing core panel.
   2. Thickness: 2-inch.
   3. Core: Glass-fiber board, ASTM C 612, of type standard with manufacturer; nominal density of 6 to 7 lb/cu. ft. unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
   4. Formed Copolymer Facing and Edges: 1/16 inch thick copolymer perforated with 3/32 inch holes on 5/32 inch staggered centers; single sheet heat formed to cover panel face and edges.
      a. Color: As selected from panel manufacturer's range of standard colors.

2.4 SURFACE-APPLIED ACOUSTIC INSULATION

A. (AST-10) Black Glass-Fiber Board Insulation: ASTM C 612, Type IA; faced on one side with black glass-fiber mat or black polymer finish; maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84.
   1. Products and Manufacturers:
      a. Permacote Linacoustic R-300 by Johns Manville;
      b. SelectSound Black Acoustic Board by Owens Corning;
   2. Acoustical Performance: Sound absorption NRC of 0.95 to 1.00 according to ASTM C 423 for Type A mounting according to ASTM E 795.
   4. Thickness: 2 inches.
   5. Finish: Matte black, unstamped.
   6. Mounting: Mechanical or Adhesive, as shown.
   7. Mechanical Fasteners:
      a. Gemco Type 0912 Insulation hanger with perforated base and S-250 self locking washer (black) and black dome cap from Goodloe E. Moore, Danville, IL
      b. Eckoustic-Klip from Eckel Industries, Cambridge, MA
      c. INC Stick-Pin from Industrial Noise Control, Addison, IL
   8. Adhesives: Use only adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 SOUND-DIFFUSING WOOD PANELS

A. (AST-24) Sound-Diffusing Wood Panels: Acoustically-engineered manufactured panels, 2-inch deep, matching WD-1. Provide Edge moulding shall provide a suitable divider allowing a fractal mounting and also provide an end termination. Edge mouldings shall be of the same wood species and finish or as specified by the architect.
   1. Products and Manufacturer:
      b. GuD Panel Geometric Uniform Diffuser by Real Acoustix.
PART 3 EXECUTION

3.1 EXAMINATION
A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting performance of sound-absorbing ceiling units.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PANELS
A. Install acoustical panels and accessories in accordance with reviewed shop drawings and manufacturer's printed instructions.
B. Install units in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
C. Comply with sound-absorbing wall unit manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.
D. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.
E. Provide for shimming and adjustments as required to maintain consistent alignment of joints and of finished panel faces.
F. Coordinate installation of panel suspension system with work of other trades.
G. Align fabric pattern and grain with adjacent units.
H. Installation Tolerances:
   1. Variation from Alignment with Surfaces: Plus or minus 1/16 inch.
   2. Variation from Level or Slope: Plus or minus 1/16 inch.
   3. Variation of Panel Butt Joints from Hairline: Not more than 1/16 inch wide.

3.3 INSTALLATION OF DIRECTLY ATTACHED ACOUSTICAL INSULATION
A. Adhesive Installation: Install acoustical insulation by bonding or stapling to substrate, using method recommended in writing by Manufacturer for Project conditions.
B. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.

3.4 INSTALLED WORK
A. Cleaning: Remove dust and other foreign materials according to manufacturer's written instructions.
B. Protection: Protect surfaces from damage and soiling until project substantial completion.
C. Replacement: At no additional cost, replace damaged materials and materials that cannot be cleaned to satisfaction of Owner.

END OF SECTION
SECTION 09 90 00
PAINTING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Painting and finishing of new and existing materials (PT)
   2. Preparation of surfaces for painting and finishing.
   3. Repainting and refinishing of existing surfaces as indicated and as specified in Section 017329
      - Cutting and Patching. Preparation of existing surfaces for repainting and refinishing.

1.2 ACTION SUBMITTALS
A. Product Data: For each paint system specified, all coats, including block fillers and primers.
   1. Submit Manufacturer's certifications that products comply with specified requirements and with
      local regulations for VOC content.
B. Samples: Submit three 4 inch by 6 inch samples of each specified finish to be reviewed for color
   and sheen. Architect reserves right to select color or finish from any manufacturer, herein specified,
   as necessary to achieve desired color or finish.
C. Product Schedule: Cross-reference to paint system and locations of application areas. Use same
   designations indicated on Drawings and in schedules. Include color designations.

1.3 CLOSEOUT SUBMITTALS
A. Maintenance Materials (Attic Stock): Furnish extra paint materials from the same production run as
   the materials applied and in the quantities described below. Package with protective covering for
   storage and identify with labels describing contents. Deliver extra materials to Owner.
   1. Quantity: Furnish Owner with extra paint materials in quantities indicated below:
      a. Interior, Paint: 3 gal. of each color applied.
      b. Exterior, Paint: 3 gal. of each color applied.

1.4 QUALITY ASSURANCE
A. Single-Source Responsibility: Provide primers and undercoat paint produced by same
   manufacturer as finish coats.
B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility
   of total systems for various substrates. On request, furnish information on characteristics of finish
   materials to ensure use of compatible primers.
C. Applicator Qualifications: Engage experienced applicator who has completed painting system
   applications similar in material and extent to that indicated for this Project with record of successful
   in-service performance.
D. Mockups: Make sample application of each paint type (PT) on project surfaces to the extent as
   directed by Architect.
   1. Obtain acceptance of sample field application before making additional applications.
   2. Accomplish work to equal or exceed standards established by approved samples. Protect and
      maintain approved field samples through completion of project.
   3. For PT-13, demonstrating 2 different paint options for final selection. Mockup shall include
      mockup of lighting conditions.
1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, color designation and instructions for mixing or reducing.

B. Provide adequate storage facilities. Store paint materials at minimum ambient temperature of 45 degrees F in well ventilated area. Restrict storage to paint materials and related equipment.

C. Take precautionary measures to prevent fire hazards and spontaneous combustion. Comply with health and fire regulations.

1.6 PROJECT CONDITIONS

A. Environmental Requirements: Comply with manufacturer's recommendations as to environmental conditions under which painting and finishing can be applied. Do not apply finish in areas where dust is being generated.

B. Measure moisture content of surfaces using electronic moisture meter. Do not apply finishes unless moisture contents of surfaces are below following maximums:
   1. Gypsum Wallboard: 12 percent.
   2. Masonry, Concrete and Concrete Block: 12 percent.
   3. Interior Wood: 15 percent.

C. Ensure surface temperature and surrounding air temperature is above 40 degrees F before applying finishes. Minimum application temperature for latex paints for interior work shall be 45 degrees F and 50 degrees F for exterior work. Minimum application temperature for transparent finish shall be 65 degrees F, or surface and air temperature shall be 5 degrees above dew point.

D. Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 45 degrees F for 24 hours before, during and 48 hours after application of finishes.

E. Provide minimum 25 foot candles of lighting on surfaces to be finished.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Manufacturers:
   1. Benjamin Moore Paints.
   2. ICI Dulux (AkzoNobel).
   3. Pratt & Lambert.
   4. PPG Architectural Finishes.
   5. Sherwin-Williams.

B. Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

C. Single-Source Responsibility: Provide primers and undercoat coating produced by same manufacturer as finish coats.

D. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
E. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Floor Coatings: 100 g/L.
9. Shellacs, Clear: 730 g/L.
10. Shellacs, Pigmented: 550 g/L.

F. Painting and Finishing Schedules: Refer to Painting and Finishing Schedules in Part 3 of this Section.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

2. Sheen: When one of following terms is used to denote specific sheen for coating listed, following index shall apply:
   a. Flat: Less than 15 units based on 85 degrees of sheen.
   b. Eggshell: 5 to 20 units based on 60 degrees of sheen.
   c. Satin/Low Lustre: 15 to 35 units based on 60 degrees of sheen.
   d. Semi-gloss: 30 to 65 units based on 60 degrees of sheen.
   e. Gloss: Above 65 units based on 60 degrees of sheen.

G. (PT) Paint Colors: Provide specified color as indicated on Material Schedule, in paint type as scheduled in this Section.

2.2 MIXING AND TINTING

A. Deliver paints ready-mixed to job site.

B. Job mixing and job tinting is not acceptable.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive paint and transparent finishes for conditions that would adversely affect execution, permanence or quality of work and which cannot be put into acceptable condition through preparatory work. Do not proceed with surface preparation or coating application until conditions are suitable.

3.2 PREPARATION OF SURFACES

A. Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as specified, for each particular substrate condition.

1. Remove mildew, by scrubbing with solution of detergent, bleach and warm water. Rinse with clean water and allow surface to dry completely.
2. Provide barrier coats over incompatible primers or remove and reprime as required. Notify Architect in writing of anticipated problems in using specified coating systems with substrate primed by others.

B. Remove hardware, hardware accessories, plates, lighting fixtures, and similar items in-place and not to be finish painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items by workmen skilled in trades involved.

C. Clean surfaces to be painted before applying paint or surface treatment. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Program cleaning and painting so that dust and other contaminants from cleaning process will not fall in wet, newly painted surfaces.
   1. Remove dirt, grease and oil from canvas and cotton insulated coverings.

D. Cementitious Materials: Prepare cementitious surfaces of concrete, concrete block and cement plaster to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze. Determine alkalinity and moisture content of surfaces to be painted by performing appropriate tests. If surfaces are found to be sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application of paint.
   1. Remove contamination, acid etch and rinse new concrete floors with clear water. Ensure required acid alkali balance is achieved. Allow to thoroughly dry. Repeat procedure if necessary to achieve a medium sandpaper-like profile.
   2. Remove dirt, loose mortar, scale, powder and other foreign matter from concrete and concrete block surfaces which are to be painted or to receive clear seal. Remove oil and grease with solution of trisodium phosphate, rinse well and allow to thoroughly dry.
   3. Remove stains from concrete and concrete block surfaces caused by weathering of corroding metals with solution of sodium metasilicate after being thoroughly wetted with water. Allow to thoroughly dry.

E. Gypsum Wallboard: Remove contamination from gypsum wallboard surfaces and prime to show defects, if any. Paint after defects have been remedied.

F. Plaster Surfaces: Fill hairline cracks, small holes and imperfections on plaster surfaces with patching plaster. Smooth off to match adjacent surfaces. Wash and neutralize high alkali surfaces where they occur.

G. Galvanized Surfaces: Clean free of oil and surface contaminates with acceptable non-petroleum based solvent.

H. Ferrous Metals: Clean non-galvanized, ferrous surfaces that have not been shop-coated of oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning, complying with Steel Structures Painting Council (SSPC)-SP3.
   1. Touch-up shop-applied prime coats which have damaged or bare areas. Wire-brush, solvent-clean, and touch-up with same primer as shop coat.
   2. Clean unprimed steel surfaces by washing with solvent. Apply treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to indicate defects, if any. Paint after defects have been remedied.

I. Wood: Clean wood surfaces to be painted of dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off.
1. Prime or seal wood required to be job painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood.

2. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood-filler. Sandpaper smooth when dried.

J. Existing Surfaces to be Repainted or Refinished: Wash surfaces to remove grease, oil, soil or other matter which will interfere with proper bond of new materials. Scrape and wire brush loose or flaking paint. Fill cracks, voids or other defects.

3.3 MATERIALS PREPARATION
A. Mix and prepare painting materials and transparent finish materials in accordance with manufacturer's directions.

B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in clean condition, free of foreign materials and residue.

C. Stir materials before application to produce mixture of uniform density, and as required during application of materials. Do not stir any film that may form on surface into material. Remove film and, if necessary, strain material before using.

3.4 APPLICATION
A. Application Procedures: Apply paints and coatings by spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.

2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.

3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

4. Apply each coat at proper consistency.

5. Each coat of paint shall be slightly darker than preceding coat unless otherwise approved by Architect.

6. Provide finish coats which are compatible with prime paints used.

B. Do not apply succeeding coats until previous coat has completely dried. Sand between each enamel or varnish coat application with fine sandpaper, or rub surfaces with pumice stone where required to produce even, smooth surface in accordance with coating manufacturer's directions.

1. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.

C. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive film thickness equivalent to that of flat surfaces.

D. Finish doors on tops, bottoms, and side edges same as exterior faces, unless otherwise indicated.

E. Film Thickness: Apply materials in accordance to paint manufacturer's recommendations and spreading rates to provide total dry film thickness as recommended.

1. Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated

2. Use precision instruments designed for measuring and evaluation wet and dry films of paints and coatings.

3. Results measuring less than recommended thickness will require additional material application.
4. Use of poor hiding colors may require application of additional coats in order to achieve proper coverage and hiding.

F. Apply first-coat material to surfaces that have been cleaned, pre-treated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

G. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of undercoat.

H. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure finish coat with no burn-through or other defects due to insufficient sealing.

I. Stipple Enamel Finish: Roll and redistribute paint to even and fine texture. Leave no evidence of rolling such as laps, irregularities in texture, skid marks, or other surface imperfections.

J. Transparent Finish: On exposed portions, use multiple coats to produce glass-smooth surface film continuity of even luster. Provide finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats, unless otherwise indicated.

K. Repainting of Existing Surfaces: Where repainting of existing surfaces is required, repaint wall and ceiling surfaces in their entirety, patch or spot painting is not acceptable.

L. Paint surfaces behind movable equipment or furniture same as similar exposed surfaces. Paint surfaces behind permanently-fixed equipment or furniture with prime coat only.

M. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.5 MECHANICAL AND ELECTRICAL EQUIPMENT

A. Refer to mechanical and electrical documents with respect to field painting and finishing requirements. Painting of mechanical and electrical work is not required in pipe chases, tunnels, and mechanical rooms with unpainted walls.

B. Remove grilles, covers and access panels for mechanical and electrical systems from location and paint separately.

C. Finish paint primed equipment to color selected.

D. Prime and paint insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with prefinished coating, or where they are not in finished space or room.

E. Paint interior surfaces of air ducts, convectors and baseboard heating cabinets that are visible through grilles and louvers before installation of equipment with 1 coat of flat black paint, to limit of sight line. Paint dampers exposed immediately behind louvers, grilles, convectors and baseboard cabinets to match face panels.

F. Paint exposed piping, insulated piping and conduit occurring in finished areas. Color and texture to match adjacent surfaces.

G. Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

3.6 CLEANING

A. As work proceeds and upon completion, promptly remove paint where spilled, splashed or spattered. Touch up and restore damaged or defaced painted areas.
B. During progress of work keep premises free from unnecessary accumulation of tools, equipment, surplus materials and debris. Remove at end of each workday.

C. Upon completion of work clean window glass and other paint-spattered surfaces and leave premises neat and clean, to satisfaction of Architect.

3.7 PROTECTION

A. Adequately cover or otherwise protect finished work of other trades and other surfaces from paint and damage. Repair damage as result of inadequate or unsuitable protection as acceptable to Architect.

1. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

B. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.

C. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items shall be carefully stored, cleaned and replaced on completion of work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

D. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

3.8 EXTERIOR PAINTING AND FINISHING SCHEDULE

A. Non-Ferrous Metal Surfaces (Galvanized):

1. Surfaces Included:
   a. Steel lintels, lintel plates, relieving angles.
   b. Hollow metal doors and frames.

   a. Primer: 1 coat Direct to Metal Primer and Flat Finish (or 1 coat touch-up if preprimed).

B. Ferrous Metal Surfaces (Steel, Iron):

1. Surfaces Included:
   a. Roof ventilators, roof vents.
   b. Metal roof stacks.
   c. Metal roof hatches.
   d. Exterior ferrous metal.

   a. Primer: 1 coat Direct to Metal Primer and Flat Finish (or 1 coat touch-up if preprimed).

C. Concrete Masonry Surfaces:

1. Surfaces Included: Walls.

2. Water Based System (Low VOC): 100 percent Acrylic Latex Finish over Heavy Duty Acrylic Block Filler.
   a. Block Filler: 1 coat Heavy Duty Acrylic Block Filler.
3.9 INTERIOR PAINTING AND FINISHING SCHEDULE

A. Concrete Unit Masonry Surfaces:
   1. Surfaces Included: Walls.
   2. Waterborne Low VOC, Low Odor System: Low VOC, Low Odor Acrylic Finish over Latex Block Filler, not less than 35 percent solids, ammonia free coating.
      a. Block Filler: 1 coat Heavy Duty Acrylic Block /Filler.
      b. Finish: 2 coats Interior Eggshell Enamel.

B. Ferrous and Non-Ferrous Metal Surfaces:
   1. Surfaces Included:
      a. Hollow metal doors and frames.
      b. Steel stairs, ladders and railings.
      c. Pre-painted surfaces.
      d. Prime painted hardware.
      e. Radiator, convector and other heating unit covers.
      f. Uninsulated piping and ductwork.
      g. Metal access panels.
      h. Metal louvers and grilles.
      i. Electric panels (over factory finish).
      j. Fire horns.
      k. Metal supports for counters, benches and shelves.
      l. Exposed and miscellaneous metals.
      m. Other exposed to view interior ferrous metals not factory finished.
      a. Primer: 1 coat Direct to Metal Primer & Flat Finish.
      b. Finish: 2 coats Benjamin Moore Natura Eggshell #513.

C. Gypsum Wallboard Surfaces:
   1. Surfaces Included:
      a. Gypsum wallboard, including over skim coat of joint compound.
      b. Apply additional coat of primer under deep tone finish paint.
      c. Sheens - General: Unless noted otherwise on Room Finish Schedule.
         1) Walls: Eggshell
         2) Ceilings and Soffits: Flat
         3) Walls where indicated on Room Finish Schedule: Semi-gloss.
         4) microbial growth resistant finish #16-551 Series - (2.0 - 3.0 mils dry thick).
      a. Primer: 1 coat Benjamin Moore Natura Primer #511.
      b. Finish: 2 coats Benjamin Moore Natura Eggshell #513, Flat #512 and Semi-Gloss *514.

D. Gypsum Wallboard Surfaces for A/V Projection:
   1. Surface Prep: Provide GA Level 5 finish.
   2. Paint Basis of Design: PT-8, as Screen Goo Projection Screen Coatings (PT-8). Apply in accordance with Manufacturer’s instructions and recommendations.

E. Wood Surfaces Painted:
   1. Surfaces Included:
      a. Wood for paint finish.
      b. Concealed surfaces of wood items to be back-primed
      a. Primer: 1 coat Interior Water-Based Primer.
      b. Finish: 2 coats Interior Eggshell Enamel.

F. Insulated items in rooms with painted walls:
1. Surfaces Included:
   a. Piping, ducts, tanks, and equipment.
2. Waterborne System: Premium Quality Acrylic Latex finish over Vapor Barrier Primer.
   a. Primer: 1 coat Vapor Barrier Primer Sealer.
   b. Finish:
      1) 2 coats Interior Latex Eggshell.
      2) 2 coats Latex Flat Finish.

G. Black Enamel Finish:
1. Surfaces Included:
   a. Duct throats for visible distance but not less than approximately 24 inches behind supply or return air grilles, registers, louvers.
   b. Wood blocking exposed at reveals.
   a. Finish: 1 coat Interior Latex Flat Black Finish.

H. Metal Ceilings:
1. Coordinate with Division 05 for shop-applied primer.
2. Surfaces Included:
   a. Bar joist, decking and supports.
   b. Galvanized ductwork.
   c. Other overhead metal surfaces.
3. Dry Fall Spray-Applied Waterborne Systems: Waterborne Dryfall over Waterborne Metal Primer
   a. Primer (touch-up if pre-primed): 1 coat.
   b. Finish: 1 coat S-W Waterborne Acrylic Dry Fall.

I. Insulation-Wrapped Piping and Equipment:
1. Surfaces Included: Piping, ducts, tanks, and equipment.
   a. Primer: 1 coat.
   b. Finish: 2 coats.

3.10 REPAINTING OF EXISTING SURFACES

A. Existing Surfaces:
1. Surfaces Included:
   a. Existing surfaces where indicated to be repainted.
   b. Existing metal lockers (casework) (metal toilet compartments) where indicated to be repainted.
2. Low-VOC Latex System:
   a. Primer/Finish: 2 coats paint similar to type listed above.
3. Electrostatic System:
   a. Primer/Finish: 2 coats electrostatic paint finish.

END OF SECTION
SECTION 09 96 00
HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. High-performance coatings (HPC) for metal surfaces.
      2. Surface preparation.

1.2 ACTION SUBMITTALS
   A. Product Data: For each coating system specified, all coats, including fillers and primers.
      1. Submit Manufacturer's certifications that products comply with specified requirements and with
         local regulations for VOC content.
   B. Samples: Submit three 4 inch by 6 inch samples of each specified finish to be reviewed for color
      and sheen. Architect reserves right to select color or finish from any manufacturer, herein specified,
      as necessary to achieve desired color or finish.
   C. Product Schedule: Cross-reference to coating system and locations of application areas. Use same
      designations indicated on Drawings and in schedules. Include color designations.

1.3 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials, from the same product run, that match products installed and that are
      packaged with protective covering for storage and identified with labels describing contents.
   B. Leave on premises, where directed by Architect, not less than 1 unopened gallon of each color
      used.
   C. Tightly seal containers and clearly label for identification.

1.4 QUALITY ASSURANCE
   A. Coordination of Work: Review other sections in which primers are provided to ensure compatibility
      of total systems for various substrates.
      1. On request, furnish information on characteristics of finish materials to ensure use of
         compatible primers.
   B. Approved Applicator: Applicator shall have not less than 3 years of successful experience in
      installation of similar coating systems and shall be certified in writing as manufacturer's licensed or
      approved applicator.
   C. Owner reserves the right to have testing agency test materials used as often as deemed necessary
      during period when coatings are being applied to ensure that product materials being used comply
      with specified requirements.

1.5 DELIVERY, STORAGE AND HANDLING
   A. Deliver coating materials in sealed original labeled containers, bearing manufacturer's name, type
      of coating, brand name, color designation and instructions for mixing or reducing.
   B. Provide adequate storage facilities. Store coating materials at minimum ambient temperature of 45
      degrees F. in well ventilated area. Restrict storage to coating materials and related equipment.
C. Take precautionary measures to prevent fire hazards and spontaneous combustion. Comply with health and fire regulations.

1.6 PROJECT CONDITIONS

A. Environmental Requirements: Comply with manufacturer’s recommendations for environmental conditions under which coating and finishing can be applied.
   1. Do not apply finish in areas where dust is being generated.

B. Ensure surface temperature or surrounding air temperature is between 50 degrees F. and 90 degrees F. before applying finishes.
   1. Minimum application temperature for exterior work is 50 degrees F.

C. Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 45 degrees F. for 24 hours before, during and 48 hours after application of finishes.

D. Provide minimum 25 foot candles of lighting on surfaces to be finished.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Acceptable Manufacturers:
   1. Tnemec Company, Inc.,
   2. Sherwin Williams,
   3. ICI/Dulux,
   4. Pittsburg Paints,

B. Compatibility: Provide materials that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer of coating system based on testing and field experience.

C. Single-Source Responsibility: Provide primers and undercoat coating produced by same manufacturer as finish coats.

D. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction, and, for interior coatings applied at project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24)]:
   1. Flat Paints and Coatings: 50 g/L.
   2. Nonflat Paints and Coatings: 150 g/L.
   3. Primers, Sealers, and Undercoaters: 200 g/L.
   4. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: 250 g/L.
   6. Pre-Treatment Wash Primers: 420 g/L.
   7. Floor Coatings: 100 g/L.
   8. Shellacs, Clear: 730 g/L.
   9. Shellacs, Pigmented: 550 g/L.

E. (HPC) Colors: Provide high-performance coating type as specified in this Section, in color as indicated on the Material Identification List and matching corresponding paint color (PT).

2.2 COATINGS SCHEDULE

A. Interior Ferrous Steel: Interior ferrous metal surfaces including stairs and railings, metal fabrications.
1. Surface Preparation: Solvent cleaning and sweep blast cleaning as recommended by system Manufacturer and as specified in Part 3 of this Section. Touch-up non-galvanized steel surfaces with high-zinc coating.

   a. Primer: Series 27WB Typoxy by Tnemec.
      1) Application: 4.0 to 6.0 dry mils.
   b. Intermediate: Series 27WB Typoxy by Tnemec.
      1) Application: 4.0 to 6.0 dry mils.
   c. Finish: Series 1080 Endura-Shield by Tnemec.
      1) Application: 2.0 to 3.0 dry mils.
      2) Sheen: Eggshell.
   d. System Total Dry Film Thickness: 10 to 15 dry mils.

B. Interior and Exterior Galvanized Steel: Including railings, metal fabrications, exposed steel angles and lintels, bollards.

1. Surface Preparation: Solvent cleaning and sweep blast cleaning as recommended by system Manufacturer and as specified in Part 3 of this Section. Touch-up non-galvanized steel surfaces with high-zinc coating.

      1) Application: 2.5 to 3.5 dry mils.
   b. Intermediate: Series 27WB Typoxy by Tnemec.
      1) Application: 4.0 to 6.0 dry mils.
   c. Finish: Series 1095 Endura-Shield by Tnemec.
      1) Application: 2.0 to 3.0 dry mils.
      2) Sheen: Gloss.
   d. System Total Dry Film Thickness: 8.5 to 12.5 dry mils.

2.3 MIXING AND TINTING

A. Deliver coatings and enamel ready-mixed to job site. Accomplish job mixing and job tinting only as approved by Manufacturer. Use tinting materials recommended by Manufacturer for specified system and application.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Examine surfaces to receive high performance coatings for conditions that would adversely affect execution, permanence or quality of work and which cannot be put into acceptable condition through preparatory work.
   1. Do not proceed with surface preparation or coating application until conditions are suitable.

B. Adequately cover or otherwise protect finished work of other trades and other surfaces from coating and damage.

C. Remove surface hardware, fittings and fastenings, prior to coating operations. These items shall be carefully stored, cleaned and replaced on completion of work in each area.

3.2 PREPARATION OF SURFACES

A. Perform preparation and cleaning procedures in accordance with coating manufacturer’s instructions and as specified, for each particular substrate condition.
   1. Remove mildew, by scrubbing with solution of detergent, bleach and warm water.
a. Rinse with clean water and allow surface to dry completely.

2. Remove surface contamination from aluminum surfaces requiring finish by steam, high pressure water or solvent washing.
   a. Apply etching primer or acid etch.
   b. Apply coating immediately if acid etching.

3. Provide barrier coats over incompatible primers or remove and reprime as required.
   a. Notify Architect in writing of anticipated problems in using specified coating systems with substrate primed by others.

B. Finishes for steel labeled Architecturally Exposed Steel shall comply with these additional requirements: smooth exposed surface and edges, including welds, by grinding and fill depressions, voids and holes with weld material and/or auto body filler, sand smooth, prime and coat.

C. Clean surfaces to be coated before applying coating or surface treatment. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning.
   1. Program cleaning and coating so that dust and other contaminants from cleaning process will not fall in wet, newly coated surfaces.
      a. Apply compatible sealer or primer.

D. Equipment used for blast cleaning shall be of type that has proper oil and water filters and traps on compressors and/or tanks so that sandblasting material is not being re-contaminated by oil and water in the air blast.

E. Ferrous Metals: Clean non-galvanized, ferrous surfaces that have not been shop-coated of oil, grease, loose mill scale and other foreign substances by solvent or mechanical cleaning, complying with Steel Structures Painting Council (SSPC)-SP6.
   1. Touch-up shop-applied prime coats which have damaged or bare areas. Wire-brush, solvent clean, and touch-up with same primer as shop coat.
      a. Clean unprimed steel surfaces by washing with solvent. Apply treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned.
      b. Prime surfaces to indicate defects. Coat after defects have been remedied.
      c. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather out edges to make touch-up patches inconspicuous.
      d. Clean surfaces with solvent. Prime bare steel surfaces. (Prime steel including shop primed steels.)

F. Strictly adhere to all finish manufacturers recommendations for preparation of each specific type of substrate.

G. Remove finish hardware, fixture covers, and accessories and store.

H. Protect adjacent surfaces and materials not receiving coating from spatter and overspray; mask if necessary to provide adequate protection. Repair damage.

3.3 MATERIALS PREPARATION

A. Mix and prepare coating materials and transparent finish materials in accordance with manufacturer's directions.

B. Store materials not in actual use in tightly covered containers.
   1. Maintain containers used in storage, mixing, and application of coating in clean condition, free of foreign materials and residue.

C. Stir materials before application to produce mixture of uniform density, and as required during application of materials.
   1. Do not stir film which may form on surface into material.
2. Remove film and, if necessary, strain material before using.

3.4 APPLICATION

A. Schedule Coatings: Apply first coat to surfaces that have been cleaned, pre-treated or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration.
   1. Number of coats and film thickness required is the same regardless of application method employed.

B. Apply high performance coating with brush, roller, spray, or other acceptable practice in accordance with manufacturer's directions.
   1. Use brushes best suited for type of material being applied. Use rollers of carpet, velvet back, or high pile sheep wool recommended by coating manufacturer for material and texture required.
      a. Apply each coat at proper consistency.
      b. Each coat shall be slightly darker than preceding coat unless otherwise approved by Architect.
      c. Provide finish coats which are compatible with prime coatings used.

C. Do not apply succeeding coats until previous coat has completely dried, unless directed otherwise by manufacturer.
   1. Sand between each enamel or varnish coat application with fine sandpaper, or rub surfaces with pumice stone where required to produce even, smooth surface in accordance with coating manufacturer's directions.

D. Apply additional coats when undercoats, or other conditions show through final coat, until coating film is of uniform finish, color and appearance.
   1. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive film thickness equivalent to that of flat surfaces.
      a. Apply each material at not less than manufacturer's recommended spreading rate, to provide total dry film thickness as recommended.
      b. Apply first-coat material to surfaces that have been cleaned, pre-treated or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration.

E. Allow sufficient time between successive coatings to permit proper drying.
   1. Do not recoat until coat has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat does not cause lifting or loss of adhesion of undercoat.

F. Prime Coats: Recoat primed and sealed areas where there is evidence of suction spots or unsealed areas in first coat, to assure finish coat with no burn-through or other defects due to insufficient sealing.

G. Stipple Enamel Finish: Roll and redistribute coating to even and fine texture. Leave no evidence of rolling such as laps, irregularities in texture, skid marks, or other surface imperfections.

H. Brush Application: Brush-out and work brush coats onto surfaces in even film.
   1. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropeyness, or other surface imperfections will not be acceptable.
   2. Neatly draw glass and color break lines.

3.5 INSTALLED WORK

A. Cleaning: As work proceeds, promptly remove coating where over-sprayed, splashed, spattered or spilled.
B. Repair: Touch-up and restore damaged.

C. Provide "Wet Paint" signs as required to protect newly coated finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of coating operations.

END OF SECTION
SECTION 10 11 00
VISUAL DISPLAY BOARDS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Markerboards (MKBD).
   2. Tackboards (TKBD).

1.2 ACTION SUBMITTALS
A. Product Data: For each display board specified.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Show location of panel joints.
   2. Show location of special-purpose graphics for visual display surfaces.
   3. Include sections of typical trim members.
C. Samples: For each type of visual display surface indicated and as follows:
   1. Visual Display Surface: Not less than 8-1/2 by 11 inches, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
   2. Trim: 6-inch- long sections of each trim profile.
   3. Accessories: Full-size Sample of each type of accessory.

1.3 QUALITY ASSURANCE
A. Installer Qualifications: An authorized representative of motor-operated, sliding visual display unit manufacturer for installation and maintenance of units required for this Project.
B. Mockups: Construct mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 WARRANTY
A. Warranty Period: Lifetime, unlimited warranty.
B. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Surfaces lose original writing and erasing qualities.
      b. Surfaces become slick or shiny.
      c. Surfaces exhibit crazing, cracking, or flaking.
   2. Warranty Period: 50 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers:
1. Carolina Chalkboard.
2. Claridge Products.
4. ADP Lemco Incorporated.

2.2 MARKERBOARDS

A. (MKBD-1) Porcelain-Enamel Marker Boards: Balanced, high-pressure, factory-laminated marker board assembly of three-ply construction consisting of backing sheet, core material, and porcelain-enamel face sheet.
   1. Porcelain-Enamel Face Sheet: Manufacturer's standard steel sheet with porcelain-enamel coating fused to steel; uncoated thickness indicated.
      a. Matte Finish: Low reflective; marker wipes clean with dry cloth or standard eraser.
      b. Color: Custom color as selected by Architect.
   2. Manufacturer's Standard Core: Minimum 1/4 inch thick, with manufacturer's standard moisture-barrier backing.
   3. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.
   4. Extruded Aluminum: ASTM B 221, Alloy 6063; clear anodic finish, AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

2.3 TACKBOARDS

A. (TKBD-1) Plastic-Impregnated-Cork Sheet: 1/4-inch seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout.
   1. Flame Spread Rating: Class A Fire Rating per ASTM E84 Complying with ASTM E84, with flame spread rating of 25.
   2. Color: See Material Identification List.
B. Extruded Aluminum J-Trim: ASTM B 221, Alloy 6063; clear anodic finish, AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

2.4 INSTALLATION ACCESSORIES

A. Mechanical Fasteners: Stainless steel standoffs, 2-inches diameter, 1/2-inch standoff, resilient gasket.
B. Adhesive: Install using adhesive as recommended by marker board Manufacturer, or as follows:
   1. GE Silglaze II.
   2. GE Silpruf.
   3. Dow Corning 795.
   4. Dow Corning 995, concealed metal mounting hardware.

2.5 FABRICATION

A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.
B. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board.
C. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.
1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which visual display boards are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install visual display boards in accordance with reviewed shop drawings and manufacturer's printed instructions. Keep perimeter lines straight, plumb and level.

B. Provide grounds, clips, backing, brackets, anchors, trim and accessories. Use splines at joints to maintain surface alignment and smooth joints.

C. Clean units in accordance with manufacturer's instructions.
SECTION 101414
CUSTOM ILLUMINATED SIGNAGE

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Custom-fabricated, illuminated exterior signage (ACR-1).

1.2 ACTION SUBMITTALS
A. Shop Drawings: Indicate overall construction of unit, with accommodations for attachment to building, electrical service, and access for maintenance.
   1. Show attachment to existing building.
   2. Show adjacent metal panels.
   3. Show locations of electrical service connections.
   4. Include diagrams for power, signal, and control wiring.
B. Samples: For each exposed material and finish.
C. Fabrication Sample: For each type of sign assembly showing all components and with the required finishes, in manufacturer’s standard size unless otherwise indicated and as follows:
   2. Variable Component Materials: Full-size sample of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
   3. Exposed Accessories: Full-size sample of each accessory type.
   4. Full-size Samples, if approved, will be returned to Contractor for use in Project.

1.3 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Manuals.

1.4 QUALITY ASSURANCE
A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
B. Installer Qualifications: Fabricator of products.

1.5 PROJECT CONDITIONS
A. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.6 DELIVERY, STORAGE AND HANDLING
A. Deliver letters in manufacturer’s protective packaging. Handle finished surfaces with care to prevent damage.
B. Deliver and handle system components to prevent damage to finished surfaces.
C. Store and protect system components in accordance with manufacturer’s recommendations.
D. Provide wrapping or strippable coating to protect prefinished aluminum surfaces. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather.

1.7 COORDINATION
A. Coordinate placement of anchorage devices for installing signs.

1.8 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 ILLUMINATED SIGNAGE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. (ACR-1) Illuminated Signage: Custom, shop-fabricated assembly constructed of aluminum channel frame and translucent acrylic faces, in configuration as shown; to be back-lit for light box effect.

C. Frames:
   1. Aluminum Sheet and Plate: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32.
   2. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.

D. Translucent Acrylic Sheet: 0.236 inch thick, ASTM D 4802, Category A-1 or B-1, Finish 1 (smooth or polished), Type UVF (UV filtering), Combustibility Class CC2, white color.
   1. Manufacturers and Products:
      a. Altuglas International, Division of Arkema Inc.; Plexiglas G.
      b. Cyro Industries, a subsidiary of Degussa Corporation; Acrylite GP.
      c. Altuglas International, Division of Arkema Inc.; Plexiglas MC.
      d. Cyro Industries, a subsidiary of Degussa Corporation; Acrylite FF.
      e. Lucite International; Lucite CP.
      f. Plaskolite, Inc.; Optix.

E. Illumination: Backlighted construction with LED lighting including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from character surfaces as needed to illuminate evenly.
   1. Power: As indicated on electrical Drawings. Provide electrical components, devices, and accessories that are listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Power: As indicated on electrical Drawings.
   3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2.2 INSTALLATION ACCESSORIES

A. Anchors and Inserts: Provide stainless steel anchors and inserts.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned [EPDM] [or] [silicone] gaskets complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal.

C. Glazing Sealants: Silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Use NT. Comply with sealant and glass manufacturers’ written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
   1. VOC Content: For sealants used inside the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Colors of Exposed Glazing Sealants: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].

D. Fasteners and Accessories: Manufacturer’s standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.
   3. Use exposed fasteners with countersunk Phillips screw heads, fabricated from Series 300 stainless steel.

2.3 FABRICATION

A. Preassemble in the shop to greatest extent possible. Disassemble only as necessary for shipping and handling limitations.

B. Fabricate to allow access for servicing lighting fixtures and for cleaning and maintaining plastic panels.

C. Provide for drainage of incidental water.

D. Fabricate corners and connections to achieve seamless and monolithic appearance. Conceal all fasteners and anchors.

E. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine supporting members to ensure that surfaces are at elevations indicated or required to comply with authorities having jurisdiction and are free from dirt and other deleterious matter.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Verify that electrical service is correctly sized and located to accommodate signs.
3.2 INSTALLATION

A. General: Install signs in accordance with reviewed shop drawings and manufacturer's printed instructions. Set letters plumb, level and true to line, and securely attach to adjacent construction.
   1. Locate signs and accessories where indicated, using mounting methods as indicated.
   2. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
   3. Do not install damaged components.
   4. Fit joints to produce hairline joints free of burrs and distortion.
   5. Rigidly secure nonmoving joints.
   6. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and impediments to movement of joints.
   7. Weld components in concealed locations to minimize distortion or discoloration of finish.
      Protect glazing surfaces from welding.
   8. Seal joints watertight unless otherwise indicated.

B. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

3.3 ERECTION TOLERANCES

A. Erection Tolerances: Install to comply with the following non-accumulating maximum tolerances:
   1. Plumb: 1/8 inch in 10 feet.
   2. Level: 1/8 inch in 20 feet.
   3. Alignment:
      a. Where surfaces are in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
      b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
      c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

3.4 CLEANING AND PROTECTION

A. Protection and Repair:
   1. Protect surrounding Work as necessary to prevent damage during installation.
   2. Fabricator/Installer is responsible for general clean-up of site area but is not responsible for extensive landscaping or restoration of architectural elements due to damage or sun bleaching by previous signs.

B. After installation, clean soiled sign surfaces as recommended by signage fabricator/installer. Protect signs from damage until acceptance by Owner.

C. At completion of installation, clean exposed sign surfaces in accordance with the manufacturer’s instructions. Signs shall be free of glue, fingerprints, dirt, grease, or any other imperfections.

END OF SECTION
SECTION 101419
DIMENSIONAL LETTER SIGNAGE

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Interior and exterior dimension letter signage (ORN MET-7).

1.2 COORDINATION
A. Coordinate placement of anchorage devices for installing signs.

1.3 ACTION SUBMITTALS
A. Shop Drawings: Indicate overall construction of unit, with accommodations for attachment to building, electrical service, and access for maintenance.
   1. Provide graphic elements and layout for each sign.
   2. Illuminated Signage:
      a. Show locations of electrical service connections.
      b. Include diagrams for power, signal, and control wiring.

B. Samples: For each size and font, submit 1 full scale letter sample using specified materials and finishes.

1.4 CLOSEOUT SUBMITTALS
A. Maintenance Data: For signs to include in maintenance manuals.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: Fabricator of products.

B. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1.6 WARRANTY
A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2.2 DIMENSION LETTER IDENTIFICATION

A. Cutout Characters: Characters with uniform faces; smooth, square edges; precisely formed lines and profiles.
   1. Configuration: Typeface, Height, and Text as indicated on Drawings.

B. Fabricated Channel Characters: Form exposed faces and sides of characters to produce surfaces free from warp and distortion. Include internal bracing for stability and attachment of mounting accessories.
   1. Configuration: Typeface, Height, and Text as indicated on Drawings.
   2. Provide manufacturer's hardware for projection mounting of channel characters at.
   3. Provide wall stand-off mounting accessories as recommended by Fabricator.
   4. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Illuminated Characters: Backlighted character construction with LED lighting including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from character surfaces as needed to illuminate evenly.
   1. Power: As indicated on electrical Drawings.
   2. Weeps: Provide weep holes to drain water at lowest part of exterior characters. Equip weeps with permanent baffles to block light leakage without inhibiting drainage.

2.3 MATERIALS

A. Aluminum:
   1. Aluminum Sheet: Not less than 0.090 inch thick.
   2. Aluminum Castings: ASTM B 26/B 26M, of alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated.
   3. Aluminum Sheet and Plate: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32.
   4. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.

B. Stainless Steel:
   1. Stainless-Steel Sheet: Not less than 0.050 inch thick for face and 0.031 inch thick for returns.
      a. Finish: No. 4.
   2. Stainless-Steel Sheet: ASTM A 240 or ASTM A 666, Type 316, stretcher-leveled standard of flatness.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.
   3. Use exposed fasteners with countersunk Phillips screw heads, fabricated from Series 300 stainless steel.
2.4 FABRICATION

A. General: Provide manufacturer's standard signs of configurations indicated.
   1. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.
   2. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
   3. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
   4. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

B. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
   2. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine supporting members to ensure that surfaces are at elevations indicated or required to comply with authorities having jurisdiction and are free from dirt and other deleterious matter.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install signs in accordance with reviewed shop drawings and manufacturer's printed instructions. Set letters plumb, level and true to line, and securely attach to adjacent construction.
   1. Locate signs and accessories where indicated, using mounting methods as indicated.
   2. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
   3. Do not install damaged components.
   4. Fit joints to produce hairline joints free of burrs and distortion.
   5. Rigidly secure nonmoving joints.
   6. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and impediments to movement of joints.
   7. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
   8. Seal joints watertight unless otherwise indicated.

B. Metal Protection:
1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.

2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

3.3 ERECTION TOLERANCES

A. Erection Tolerances: Install to comply with the following non-accumulating maximum tolerances:
   1. Plumb: 1/8 inch in 10 feet.
   2. Level: 1/8 inch in 20 feet.
   3. Alignment:
      a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
      b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
      c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

3.4 INSTALLED WORK

A. After installation, clean soiled sign surfaces as recommended by signage fabricator/installer. Protect signs from damage until acceptance by Owner.

B. At completion of installation, clean exposed sign surfaces in accordance with the manufacturer’s instructions. Signs shall be free of glue, fingerprints, dirt, grease, or any other imperfections.

END OF SECTION
SECTION 101443
PHOTOLUMINESCENT EGRESS PATH MARKINGS

GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Photoluminescent egress path markings (PEPM-1).

1.2 REFERENCES

1.3 SUBMITTALS
A. Product Data: Include product description, materials, finishes, and performance characteristics.
B. Shop Drawings: Indicate sign locations, content, mounting heights, and attachments.
C. Samples:
   1. Marking film/strip samples: 12 inches long.
   2. Perimeter demarcation strip samples: 12 inches long.
   3. Landing identification samples: 12 inches long.
   4. Door hardware marking samples: 4 x 4 inches.

1.4 DELIVERY, STORAGE AND HANDLING
A. Store markings in cool, dry location until installed.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS
A. Products and Manufacturers:
   1. Glo Brite Egress Path Markings by Jessup Manufacturing Company
   2. Safe-T-First Photo Luminescent Egress Path Marking System by Johnsonite.
B. Description:
   1. Photo luminescent material absorbing and storing energy from ambient fluorescent light, not requiring external power supply.
   2. Non-toxic, non-radioactive.
   3. High-visibility illumination.
C. Perimeter Demarcation Strips: Conformable photo luminescent film, 1-inch wide.
D. Stripe Film/Strip: 1-inch wide, black diagonal stripes, self-adhering with release-paper facing.
E. Fire Safety Signs: (by signage contract)
   1. Provide signs with indicated characters and graphic depictions.
   2. STANDPIPE: 8.75 inches wide x 12 inches high.
   3. PUSH TO EXIT: 11.25 inches wide x 5 inches high.
   4. PUSH UNTIL ALARM SOUNDS - DOOR CAN BE OPENED IN 15 SECONDS: 11.25 inches wide x 10 inches high.
   5. Running man - right: 8 x 8 inches.
   6. Running man - left: 8 x 8 inches.
F. Floor Identification Signs:
1. Size: 12 inches wide x 18 inches high.
2. Content:
   a. Stair or ramp identification.
   b. Floor level.
   c. Braille floor indicator.
   d. Exit enclosure top and bottom terminus.
   e. Roof access availability.
   f. Exit discharge direction.

G. Door and Hardware Markings: Self-adhering with release-paper facing.
1. Exit door markings: 4 x 4 inches.
2. Door hardware markings:
   a. Door handles: 4 x 4 inches.
   b. Panic bars: 1-inch high x full width of bar.

PART 3 EXECUTION

3.1 PREPARATION
A. Clean substrate surfaces of dirt, oil, grease, and loose matter that could impair adhesion.

3.2 INSTALLATION
A. Install markings in accordance with Manufacturer’s instructions and approved Shop Drawings.
B. Locate markings in accordance with Building Code.
C. Install markings straight and true to line.

3.3 SCHEDULE

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>MARKING TYPE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landings</td>
<td>Step and Landing Identification</td>
<td>Leading edge of landing within exit enclosures</td>
</tr>
<tr>
<td>Handrails</td>
<td>Marking Film/Strip</td>
<td>Entire length of each handrail within exit enclosures, located on top surface</td>
</tr>
<tr>
<td>Stair Landings and Other Floor Areas</td>
<td>Perimeter Demarcation Strips</td>
<td>Solid and continuous demarcation line on floor or wall within exit enclosures, excluding sides of steps</td>
</tr>
<tr>
<td>Exit Doors</td>
<td>Exit Door Marking</td>
<td>Each exit door within exit enclosures, centered on door with top edge maximum 18 inches above floor</td>
</tr>
<tr>
<td>Door Hardware</td>
<td>Door Hardware Marking</td>
<td>Each door handle on exit doors within exit enclosures, located behind, adjacent to, or on handle or escutcheon</td>
</tr>
<tr>
<td>Door Hardware</td>
<td>Door Hardware Marking</td>
<td>Each panic bar on exit doors within exit enclosures</td>
</tr>
<tr>
<td>Door Frames</td>
<td>Door Frame Marking</td>
<td>Head and jambs of each exit door within exit enclosures, continuous</td>
</tr>
<tr>
<td>Floor Identification</td>
<td>Floor Identification Sign</td>
<td>By Signage Contract</td>
</tr>
<tr>
<td>Fire Safety Signs</td>
<td>STANDPIPE signs</td>
<td>By Signage Contract</td>
</tr>
<tr>
<td>Fire Safety Signs</td>
<td>PUSH TO EXIT - PUSH UNTIL ALARM SOUNDS - DOOR CAN BE OPENED IN 15 SECONDS - Running man - right Running man - left signs</td>
<td>By Signage Contract</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 102100
TOILET COMPARTMENTS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Solid plastic toilet compartments and urinal screens (T COMP-1) and (T COMP-2).

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.
B. Shop Drawings: For toilet compartments.
   1. Include plans, elevations, sections, details, and attachment details.
   2. Show locations of cutouts for compartment-mounted toilet accessories.
   3. Show locations of centerlines of toilet fixtures.
   4. Show locations of floor drains.
   5. Show overhead support or bracing locations.
C. Samples: For each type of toilet compartment material indicated. Each type of material, color, and finish required for toilet compartments, prepared on 6-inch-square Samples of same thickness and material indicated for Work.

1.3 CLOSEOUT SUBMITTALS
A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.4 PROJECT CONDITIONS
A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities for toilet compartments designated as accessible.

2.2 MANUFACTURERS
A. Products and Manufacturers: Subject to compliance with specified requirements, provide Basis of Design or equivalent product, approved by Architect, by one of the following Manufacturers:
   1. Metpar Steel Products.
   2. Accurate Partitions.
   4. Scranton Products.
2.3 SOLID-PLASTIC TOILET COMPARTMENTS

A. (T COMP-1) and (T COMP-2): Floor-mounted, overhead-braced solid plastic toilet enclosures and wall-hung urinal screens.

B. Door, Panel, Screen, and Pilaster Construction: Constructed of two sheets of 1/8 inch thick high density polyethylene (HDPE), thermoformed with touch points into single engineered panel, with structural inserts on top and middle rails. Waterproof and nonabsorbent, with self-lubricating surface, resistant to marks by pens, pencils, markers, and other writing instruments.
   1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
   2. Finish: "Orange Peel".
   3. (T COMP-1) Color: "Stainless".
   4. (T COMP-2) Color: "Linen". Engraved Traditional 2600.

C. Headrail: Heavy-duty extruded aluminum, anti-grip design, integrated curtain track, clear anodized finish, fastened to headrail bracket with stainless steel tamper resistant Torx head bolt and at top of pilaster with stainless steel tamper resistant Torx head screws.
   1. Headrail Brackets: 20 gage stainless steel, satin finish, secured to wall with stainless steel tamper resistant Torx head screws.

2.4 HARDWARE AND ACCESSORIES

A. Hardware and Accessories: Manufacturer’s heavy-duty operating hardware and accessories.

B. Hinges: Manufacturer’s minimum 0.062-inch-thick stainless-steel continuous, cam type that swings to a closed or partially open position allowing emergency access by lifting door. Mount with through-bolts.

C. Latch and Keeper: Manufacturer’s heavy-duty surface-mounted cast-stainless-steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with through-bolts.

D. Coat Hook: Manufacturer’s heavy-duty combination cast-stainless-steel hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories. Mount with through-bolts.
   1. Provide coat hook at inside of stall doors.

E. Door Bumper: Manufacturer’s heavy-duty rubber-tipped cast-stainless-steel bumper at out-swinging doors. Mount with through-bolts.

F. Door Pull: Manufacturer’s heavy-duty cast-stainless-steel pull at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through-bolts.

G. Anchorages and Fasteners: Manufacturer’s standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless-steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.5 FABRICATION

A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
1. Provide formed and closed edges for doors, panels and pilasters. Miter and weld corners and grind smooth.
2. Provide internal reinforcement in areas of attached hardware and fittings. Mark locations of reinforcement for partition mounted toilet accessories.

B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

C. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
   1. Confirm location and adequacy of blocking and supports required for installation.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.
B. Examine site conditions to which work is to be applied. Do not proceed with work until unsatisfactory conditions have been corrected.
   1. Take site dimensions affecting this work.
   2. Ensure correct spacing of plumbing fixtures.
   3. Ensure correct location of built-in framing, anchorage, and bracing, where required.

3.2 INSTALLATION
A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
   1. Maximum Clearances:
      a. Pilasters and Panels: 1/2 inch.
      b. Panels and Walls: 1 inch.
   2. Install partitions secure, plumb, level, and square.
   4. Full-Height Brackets: Secure panels to walls and to pilasters with intermittent brackets.
      a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
      b. Align brackets at pilasters with brackets at walls.
B. Ceiling-Hung Units: Secure pilasters to supporting structure and level, plumb, and tighten. Hang doors and adjust so bottoms of doors are level with bottoms of pilasters when doors are in closed position.
C. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
D. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.

E. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

F. Hardware:
   1. Equip each door with hinges; one door latch, or at accessible stalls, one accessible use door latch and one door pull; and one coat hook and bumper.
   2. Install door strike keeper with door bumper on each pilaster in alignment with door latch.
   3. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

3.3 CLEANING

A. Field touch-up of scratches or defaced enamel finish will not be permitted. Damaged, scratched or marred defective materials will be rejected, and shall be replaced with new materials.

B. Remove protective maskings. Clean surfaces free of oil and imperfections.

END OF SECTION
SECTION 102600
WALL & DOOR PROTECTION

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Wall corner guards (WCG-1).
   2. Chair rails (CHR-1).

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
B. Shop Drawings: For each type of wall and door protection showing locations and extent.
C. Samples: For each type of impact-resistant wall-protection unit indicated, in each color and texture specified. Include Samples of accent strips and accessories to verify color selection.

1.3 DELIVERY, STORAGE AND HANDLING
A. Deliver wall and corner guards in manufacturer's protective covering. Handle finished surfaces with care to prevent damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers:
   1. IPC Door and Wall Protection Systems.
   2. Koroguard.
   4. MM Systems Corp.
   5. K.J.Miller Corp.
   6. Stylmark
   7. C/S Group.

2.2 METAL WALL CORNER GUARDS
A. (WCG-1) Surface-Mounted, Metal Corner Guards: Fabricated as one piece from formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
   1. Basis of Design: Inpro
   2. Material: Stainless-steel sheet, Type 430.
   3. Thickness: 16 ga...
   4. Finish: Directional satin, No. 4.
   5. Wing Size: Nominal 2 by 2 inches.
   7. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes.
2.3 CHAIR RAILS
   A. (CHR-1) Chair Rail: Snap on cover of .070" thickness extruded polyvinyl chloride on Continuous aluminum retainer of .060" thickness shall be fabricated from 6063-T5 aluminum, with a mill finish.
   1. Basis of Design: 2500 Chair Rail by IPC.
      a. Color: Designer White 0101
   2. Sizes: 2 inches high, 1 inch depth.
   3. End caps, outside corners and inside corners made of injection molded thermoplastics.

2.4 INSTALLATION ACCESSORIES
   A. Attachment Hardware: As recommended by manufacturer for wall construction type.
   C. Fasteners: Non-corrosive and compatible with aluminum retainers, supplied by wall protection manufacturer.
   D. Trim and Accessories: Edge and corner trim as required for a complete finished installation as approved by Architect.
   E. Adhesive: Type recommended by manufacturer for use with material being adhered to substrate indicated.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Examine areas and conditions in which wall surface protection components and wall protection systems will be installed.
   B. Wall surfaces to receive impact-resistant wall covering materials shall be dry and free from dirt, grease, loose paint and scale.
   C. Do not proceed with installations until unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Prior to installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION
   A. Install wall protection and corner guards and accessories in accordance with reviewed shop drawings and manufacturer's printed instructions.
   B. Install true, plumb and level, securely and rigidly anchored to substrate.
   C. Do not install damaged materials with chips, cracks, voids, or stains left exposed to view.
   D. Provide mounting hardware, splices, anchors and other accessories for complete system.

3.4 CLEANING
   A. Immediately upon completion of installation, clean plastic covers and accessories using standard ammonia based household cleaning agent. Clean metal components in accordance with manufacturer's recommendations.
   B. Remove excess adhesive using methods and materials recommended by manufacturer.
C. Remove surplus materials, rubbish and debris resulting from installation upon completion of work and leave areas of installation in neat, clean condition.

END OF SECTION
SECTION 10 28 13
TOILET ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Washroom accessories.
   2. Hand dryers.
   3. Custodial accessories.
   4. Installation of Owner-furnished accessories (OFCI).
B. Related Sections:
   1. Section 088000 - Glazing: Glass mirrors.
   2. Section 092216 - Non-Structural Metal Stud Framing: Metal anchor reinforcement in walls.

1.2 COORDINATION
A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include the following:
   1. Construction details and dimensions.
   2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
   3. Material and finish descriptions.
   4. Features that will be included for Project.
   5. Manufacturer's warranty.
   6. Installation Templates: Provide setting drawings where cutouts are required in other work, including templates, substrate preparation instructions, and directions for preparing cutouts and installing anchorage devices.
B. Samples:
   1. Finish Samples: Submit samples of each exposed finish type.
   2. Unit Samples: Full size, for each accessory item to verify design, operation, and finish requirements. Approved full-size Samples will be returned and may be used in the Work.
C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
   1. Identify locations using room designations indicated.
   2. Identify products using designations indicated.
D. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.4 DELIVERY, STORAGE AND HANDLING
A. Do not deliver accessories to site until rooms in which they are to be installed are ready to receive them.
B. Pack accessories individually in manner to protect accessory and its finish.

1.5 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights. Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 PRODUCTS

C. Product Requirements

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.
   1. Owner Approved Supplier: Allied Eagle Supply Co.

2.1 SCHEDULE OF CUSTODIAL AND TOILET ACCESSORIES

A. Schedule: Subject to compliance with specified requirements, provide Basis of Design products as indicated or equivalent products as approved by Architect.

B. General Building Accessories:
   1. (BA-1) Mop and Broom Holder with Shelf: Stainless steel shelf, 24 inches long, _ inches deep, with 3 mop & broom holders.
      a. Bobrick B-223.
   2. (BA-2) Mop and Broom Holder with Shelf: Stainless steel shelf, 36 inches long
      a. Bobrick B-224.

C. Coat Hooks:
   1. (CH-1) Single Hook: Stainless steel, satin finish.
      a. Bobrick B-76717.
      b. Bradley 9114 Bradex.
   2. (CH-2) Double Hook: Stainless steel, satin finish.
      a. Bobrick B-76727.
      b. Bradley 9124 Bradex.
   3. (CH-3) Hat and Coat Hook: Stainless steel, satin finish.
      a. Bobrick B-6827.
      b. Bradley 9134 Bradex.

D. (DRY-1) Electric Hand Dryers: Surface mounted, electric with automatic operation, polycarbonate-ABS casing, 1400 watts, voltage 110-127V.
   1. Basis of Design: Dyson Airblade dB.

E. (DRY-2) Hand Dryers: Surface-mounted, electric with automatic operation, vitreous enamel paint finish over cast iron, 1900 to 2300 watts.
   2. Operation: Electronic-sensor activated with timed power cut-off switch.
3. Motor: 60 Hz. Capacitor-initiated; brushless, for longer life and quiet operation; 1/10 HP, 3,400 RPM; self-lubricating bearings; self-resetting thermal switch.

F. (GB) Grab Bars: In accordance with ADA guidelines, capable of withstanding downward load of 250 lbf when tested according to ASTM F 446.
   1. Basis of Design:
      a. Bobrick B-6806 Series.
      b. Bradley 812 Series
   2. Material and Finish: Type 304 stainless steel pipe, 18 ga., 1-1/2” outer diameter, with satin finish on ends and slip-resistant texture in grip area.
   3. Mounting: Flanges with concealed fasteners and gasketed stainless steel escutcheon.
   4. Configurations: As indicated on Drawings. Refer to grab bar schedule in Drawings.

G. Infant Changing Station: Unit that opens by folding down from stored position by pneumatic shock-absorbing mechanism, engineered to support a minimum of 250-lb static load when opened, with child-protection strap and built-in tissue liner dispenser; in compliance with ASTM F 2285 - Standard Safety Performance Specification for Diaper Changing Tables for Commercial Use.
   1. (ICS-1) Stainless Steel, Recess-Mounted, Horizontal Orientation: Type 304 stainless steel station with HDPE formed liner.
      a. KB110-SSRE by Koala Kare Products, a division of Bobrick.

H. (MIR-1) Framed Mirrors Without Shelf: sizes as indicated.

I. (PTC-1) Dual Paper Towel Roll Dispensers: Surface-mounted, ABS plastic, translucent black; one roll in reserve.
   2. Supplier: Allied-Eagle.

J. (SDISP-1) Soap Dispenser: Wall-mounted, manual foaming soap dispenser, vertical design, translucent black plastic.
   2. Supplier: Allied-Eagle.

K. (SDISP-2) Soap Dispenser: Lavatory-mounted, manually-operated foaming soap dispenser, 4-inch spout, reservoir.
   1. Basis of Design: Lite’n Foamy Counter Mount Dispenser #967700


   2. Supplier: Allied-Eagle.


2.2 SHOWER ACCESSORIES

A. (SHCR-1) Shower Curtain Rod:

B. (SHC-1) Shower Curtain and Hooks:
1. Bobrick B-2041 hooks
2. Bobrick B-2042 curtain

C. (SHFS-4) Shower Folding Seat:
   1. Bobrick, B-5193 Folding Shower Seat, solid phenolic

### 2.3 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.0312-inch minimum nominal thickness, unless otherwise indicated.

B. Steel Sheet: ASTM A 1008, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.

C. Sheet Steel: ASTM A 366, cold rolled, commercial quality, 0.0359-inch minimum nominal thickness; surface preparation and metal pretreatment as required for applied finish.

D. Galvanized Steel Sheet: ASTM A 653, G60.

E. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).


G. Mirror Glass: ASTM C 1036, Type I, Class 1, Quality q2, nominal 6.0 mm thick, with silvering, electroplated copper coating, and protective organic coating complying with FS DD-M-411.
   1. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

H. Fasteners and Mounting Devices: Provide concealed fasteners where possible.
   1. Where fasteners remain exposed to view, provide tamper-resistant and theft-resistant fasteners, of material and finish to match accessory unit.
   2. Screws, bolts, and other devices of same material as unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

I. Fasteners, Screws, and Bolts: Hot dip galvanized.

J. Expansion Shields: Fiber, lead or rubber as recommended by accessory manufacturer for component and substrate. Provide exposed fasteners with finish to match accessories.

K. Adhesive: Epoxy type contact cement.

### 2.4 FABRICATION

A. General:
   1. Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
   2. Shop assemble components and package complete with anchors and fittings.
   3. Keys: Provide universal keys for internal access to accessories for servicing and resupplying.

B. General: Names or labels are not permitted on exposed faces of accessories. On interior surface not exposed to view or on back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer’s name and product model number.

C. Surface-Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.
D. Recessed Toilet Accessories: Unless otherwise indicated, fabricate units of all-welded construction, without mitered corners. Hang doors and access panels with full-length, stainless-steel hinge. Provide anchorage that is fully concealed when unit is closed.

E. Framed Glass-Mirror Units: Fabricate frames for glass-mirror units to accommodate glass edge protection material. Provide mirror backing and support system that permits rigid, tamper-resistant glass installation and prevents moisture accumulation.

F. Provide galvanized steel backing sheet, not less than 0.034 inch and full mirror size, with non-absorptive filler material. Corrugated cardboard is not an acceptable filler material.

G. Mirror-Unit Hangers: Provide mirror-unit mounting system that permits rigid, tamper- and theft-resistant installation, as follows:
   1. One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.

H. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner’s representative.

PART 3 EXECUTION

3.1 PREPARATION
A. Deliver inserts and rough-in frames to jobsite at appropriate time for building-in. Provide templates and rough-in measurements as required.

B. Before starting work notify Architect in writing of conflicts detrimental to installation or operation of units.

C. Verify exact location of accessories with Architect. Verify blocking is in place prior to gypsum board installation.

D. Accessory Locations: Coordinate accessory locations with other work to avoid interference and to assure proper operation and servicing of accessory units.

3.2 INSTALLATION
A. Locate toilet accessories in accordance with requirements of Texas Accessibility Standards (TAS).

B. Install fixtures, accessories and items in accordance with manufacturer’s printed instructions.

C. Install true, plumb and level, securely and rigidly anchored to substrate and sealed to protect structural elements of wall from moisture.

D. Use tamper proof (security) type fasteners.

3.3 INSTALLED WORK
A. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.

B. Clean and polish exposed surfaces in accordance with manufacturer’s recommendations after removing labels and protective coatings.

END OF SECTION
SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Fire extinguishers (FE).
   2. Fire extinguisher cabinets (FEC).
   3. Fire department key box (FDKB).
   4. Wall brackets and other accessories.
B. Related Sections:
   1. Section 099000 - Painting.
   2. Division 21 - Fire Suppression: Fire protection system.

1.2 ACTION SUBMITTALS
A. Product Data:
   1. Fire Extinguishers: Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher.
   2. Fire-Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
B. Shop Drawings: For fire-protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

1.3 DELIVERY, STORAGE AND HANDLING
A. Deliver firefighting devices in manufacturer’s protective packaging as required by project sequencing for installation. Fill and service extinguishers as required before installation.
B. Store and handle with care to prevent damage.

1.4 COORDINATION
A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
B. Coordinate with Divisions 21, 26 and 28 as needed for connection of key box to building emergency alarm system.
C. Fire Department Key Box Coordination:
   1. Coordinate with local emergency departments for master keying.
   2. Coordinate with building alarm system.
   3. Coordinate with Section 087100 - Door Hardware.

1.5 WARRANTY
A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
a. Failure of hydrostatic test according to NFPA 10.
b. Faulty operation of valves or release levers.
2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
   1. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
   2. UL-Listed Products: Provide fire extinguishers which are UL-listed and bear UL "Listing Mark" for type, rating, and classification of extinguisher indicated.
   3. FM-Listed Products: Provide fire extinguishers which are approved by Factory Mutual Research for type, rating and classification of extinguisher indicated, carrying appropriate FM marking.
B. Cabinets in Fire-Rated Walls: Provide Manufacturer’s fire-rated cabinets, listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

2.2 PRODUCTS AND MANUFACTURERS

A. Basis of Design: The design for each fire extinguisher is based on the product named. Other products subject to compliance with the requirements in this Section, and as approved by Architect.
   1. Amerex Corporation.
   2. Ansul.
   3. JL Industries.
   4. Larsen's Manufacturing.
   5. Potter Roemer, Div. of Smith Industries, Inc.

2.3 FIRE EXTINGUISHERS

A. Multipurpose Dry-Chemical Type in Steel Container: Monoammonium phosphate-based dry chemical in enameled-steel container; for Class A, B C fires; charged and bearing inspection tag with charge date; and as follows:
   1. (FE-2) 5 lb. Extinguisher: UL-rated 3-A:40-B:C.
B. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

2.4 FIRE EXTINGUISHER CABINETS

A. (FEC-1) Recessed Steel Cabinet with Flat Trim:
   2. Door Style and Material: Full glass.
   3. Glass Type: Clear, tempered glass
   4. Latch: Magnetic catch.
   5. Finish: Baked enamel finish in color as selected by Architect. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
      a. Provide manufacturer's standard.
b. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

6. Identification: Horizontal die-cut lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.

B. (FEC-2) Surface-Mounted Steel Cabinet:
   2. Door Style and Material: Full glass.
   3. Glass Type: Clear, tempered glass
   4. Latch: Magnetic catch.
   5. Finish: Baked enamel finish in color as selected by Architect. Door Hardware: Manufacturer’s standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
      a. Provide manufacturer’s standard.
      b. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
   6. Identification: Horizontal die-cut lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.

2.5 EMERGENCY KEY BOX
A. (FDKB-1) Surface-Mounted Emergency Key Box: Surface-mounted box with gasketed weather-resistant hinged door.
   1. Basis of Design: Knox-Box 3275 by Knox Company
   2. Finish: Manufacturer’s standard finish in black color as selected by Architect.

2.6 FABRICATION
A. Fire-Protection Cabinets: Provide manufacturer’s standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
   1. Weld joints and grind smooth.
   2. Provide factory-drilled mounting holes.
   3. Prepare doors and frames to receive locks.
   4. Install door locks at factory.
B. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch-thick, cold-rolled steel sheet lined with minimum 5/8-inch-thick, fire-barrier material. Provide factory-drilled mounting holes.
C. Cabinet Doors: Fabricate doors according to manufacturer’s standards, from materials indicated and coordinated with cabinet types and trim styles selected.
   1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
   2. Miter and weld perimeter door frames.
D. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

PART 3 EXECUTION
3.1 EXAMINATION
A. Examine roughing-in for hose valves and cabinets to verify actual locations of piping connections before cabinet installation.
B. Examine walls and partitions for suitable framing depth and blocking where recessed and semi-recessed cabinets will be installed.

C. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged units.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fire protection specialties and accessories according to reviewed shop drawings and manufacturer instructions.

B. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.
   1. Provide inside latch and lock for break-glass panels.
   2. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
      1. Install cabinet with not more than 1/16-inch tolerance between pipe OD and knockout OD. Center pipe within knockout.
      2. Seal through penetrations with firestopping sealant as specified in Section 078440 - Firestopping.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

D. Install in locations and at mounting heights indicated or, if not indicated, at heights to comply with applicable regulations of governing authorities.

E. Prepare recesses in walls for cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer’s instructions.

3.3 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection specialties are installed, unless otherwise indicated in manufacturer’s written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet manufacturer.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION
SECTION 107113
EXTERIOR SUN CONTROL DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 051200 Structural Steel Framing

1.2 SUMMARY

A. This section includes the following:

1. Fixed, extruded-aluminum sunshades.

1.3 DEFINITIONS

A. For fenestration industry standard terminology and definitions refer to American Architectural Manufacturers Association (AAMA) AAMA Glossary (AAMA AG).

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Combined load on sunshade configurations to be determined in accordance with ASCE 7 or applicable code requirements. Combined load consists of wind, snow and ice loads. Design sunshade configurations to withstand stresses due to combined load. Stresses resulting from thermal expansion/contraction, shall not cause permanent deformation of sunshade assemblies or disengagement from the wall system.

B. Blade deflection shall not exceed L/120 of span length.

B. Shading Performance: Design of standard configurations will allow for negligible direct sunlight to show through the blades based on project location, latitude, altitude, building orientation, surrounding conditions, and aesthetic requirements, except for round, diamond and square sunshade styles.

C. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.5 SUBMITTALS

A. Product Data: For each type of product specified.

B. Shop Drawings: For sunshade units and accessories. Include plans, elevations, sections, and details showing profiles, angles, and spacing of sunshade blades. Show unit dimensions related to wall openings and construction and profiles of frames at jamb, heads and sills, and anchorage details and locations.

1. For installed sunshades indicated to comply with design loadings, include structural analysis data signed and sealed by a qualified professional engineer responsible for their preparation.
C. Samples for Initial Section: American Warming & Ventilating’s color charts showing the full range of colors available for units with factory applied color finishes unless custom colors are called for in Paragraph 2.5.

D. Samples for Verifications: Of each type of metal finish required, prepared on samples of same thickness and material indicated for final work. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

E. Product Certificates: Signed by American Warming and Ventilating certifying that the finished products comply with requirements and are licensed to bear the AMCA seal based on tests made according to AMCA 500 and complying with AMCA's Certified Ratings Program.

F. Product Test Reports: Indicate compliance of products with requirements based on comprehensive testing of current products.

G. Qualification Data: For firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.6 QUALITY ASSURANCE

A. Professional Engineer Qualifications: A professional engineer who is legally qualified and who is experienced in providing engineering service of kind indicated. Engineering services are defined as those performed for installations of sunshades that are similar to those indicated for this project in material, design, and extent.

B. Source Limitations: Obtain sunshades and vents from a single source manufacturer where alike in one or more respects regarding type, design, and factory applied color finish.


D. Delegated Design: Sun shade to be designed and verified by supplier to meet all applicable codes, including mounting and connections.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify sunshade openings by field measurements before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

1. Establishing Dimensions: Where field measurements cannot be made without delaying the work, the general contractor shall establish opening dimensions allowing the manufacturer to proceed with fabricating sunshades without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Manufacturers Basis of Design: Subject to compliance with requirements, provide products manufactured by the following:

1. American Warming and Ventilating, Inc., 7301 International Dr. Holland, OH 43528 USA, Phone: 419-865-5000, Fax: 419-865-1375
2. Other manufacturers are acceptable and will be evaluated on ability to comply with design, performance and project requirements.

2.2 MATERIALS

A. Aluminum Extrusions: ASTM B 221, alloy 6063-T5.

B. Fasteners: Of same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.
   1. Use types, gauges, lengths to suit unit installation conditions.
   2. Use hex-head screws for exposed fasteners unless otherwise indicated.

C. Anchors and Inserts: Of type, size and material required for type of loading and installation indicated. Use nonferrous metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or expansion bolt devices for drilled-in-place anchors.

2.3 FABRICATION, GENERAL

A. Assemble sunshades in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations.

B. Weld fixed sunshade blades to outrigger frame unless otherwise indicated or size of sunshade assembly makes bolted connections between frame members necessary.

2.4 FIXED, EXTRUDED-ALUMINUM SUNSHADES CONSTRUCTION

A. Manufacture: Provide fixed-blade sunshades by American Warming and Ventilating model SC8T.

B. Horizontal Sunshade Blades: Rectangular tube blade type complying per the following:
   1. Blade width: 8 inches x 2 inches.
   2. Blade Thickness: Minimum 0.25 inch thick Extruded Aluminum 6063-T5 or T6 alloy

C. Outriggers: Minimum 1/4” Thick aluminum alloy complying per the following:
   1. Depth: 8 inches (203 mm) by length indicated on project drawings.

2.5 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.


   1. Fluoropolymer Two Coat System: Manufacturer's standard thermocured system consisting of specially
formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, complying with AAMA 2605. (20) year warranty.
   a. Custom color to match MP-1 (Evening Shade ENC-1605) or to match architects sample.

PART 3 EXECUTION

3.1 PREPARATION

   A. General Contractor to coordinate setting drawings, diagrams, templates, instruction, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. General Contractor to coordinate delivery of such items to project site.

3.2 INSTALLATION

   A. Locate and place sunshade units level, plumb, and at indicated alignment with adjacent work.

   B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

   C. Form closely fitted joints with exposed connections accurately located and secured.

   D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers as indicated.

   E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

   F. Protect galvanized and nonferrous metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

   G. Install concealed gaskets, flashings, joint fillers, and insulation, as sunshade installation progresses, where weathertight sunshade joints and required. Comply with Division 7 Section "Joint Sealants" for sealants applied during sunshade installation.

3.3 ADJUSTING, PROTECTING, AND CLEANING

   A. Protect sunshades and vents from damage during construction. Use temporary protective coverings where needed and approved by sunshade manufacturer (AWV). Remove protective coverings at the time of Substantial Completion.

   B. Restore sunshades damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by the architect, remove damaged units and replace with new units.

      1. Clean and touch up minor abrasions in finishes with air-dried coating that matches color and gloss, and is compatible with, factory-applied finish coating.

      C. Periodically clean exposed surfaces of sunshades and vents that are not protected by temporary covering to remove fingerprints and soil accumulated during construction. Do not let soil accumulate until final cleaning.

      D. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to
finishes. Thoroughly rinse surfaces and dry.
SECTION 107313
AWNINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Fixed awning with custom graphics (AWN-1).

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include styles, material descriptions, construction details, fabrication details, dimensions of individual components and profiles, hardware, fittings, mounting accessories, features, and finishes for awnings.

B. Shop Drawings:
   1. Include plans, elevations, sections, mounting heights, and attachment details.
   2. Detail fabrication and assembly of awnings, including seam layout, spacing, and orientation of awning fabric.
   3. Show locations for blocking, reinforcement, and supplementary structural support.
   4. Graphics: Show text message, font, character sizes, and other graphic forms; character, word, and line spacing; margin widths; position of copy; and other information related to graphic design.

C. Samples for Initial Selection: For each type of exposed finish.
   1. Include Samples of graphics on fabric and accessories involving color or finish selection.

D. Samples for Verification: For the following:
   1. Awning Fabric: 12-inch- square section of fabric from dye lot to be used for the Work, with specified treatments applied. Mark face of fabric.
   2. Graphics: Not less than 12-inch- square section showing graphics application method.
   3. Seam, Edge, and Corner Condition: Not less than 12-inch- long section showing seam, edge, and corner treatment.
   4. Frame Finish: Not less than 6-inch lengths.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For awnings to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of products.

C. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
1.5 WARRANTY

A. Special Warranty: Manufacturer and fabricator agree to repair or replace components of awnings that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including framework.
      b. Deterioration of fabric including seam failure.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Faulty operation of operator.
   2. Awning Warranty Period: Five years from date of Substantial Completion.
   3. Fabric Warranty Period: Five years from date of Substantial Completion.
   4. Thread Warranty Period: Five years from date of Substantial Completion.
   5. Graphics Warranty Period: Outdoor durability not less than Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 FABRIC

A. Fabric:
   1. Fiber Content: [Vinyl-laminated or -coated polyester mesh] [Vinyl-laminated or -coated polyester] [Acrylic-coated polyester] [Resin-coated polyester] [Vinyl-coated polyester/cotton blend] [Acrylic-coated polyester/cotton blend] [Resin-coated polyester/cotton blend] [Solution-dyed acrylic] [Solution-dyed modacrylic] [Expanded PTFE] <Insert description>.
   2. Weight: .
   4. Shrinkage: Not greater than \([0.1] [0.5] [1] <\text{Insert number}>\) percent according to ASTM D1204.
   5. Stretch Factor: Not less than \([0.4] [1] [4] <\text{Insert number}>\) percent according to ASTM D4851.
   6. Applied Treatment: [Stain resistant] [Mildew resistant] [Polymer, flame resistant] [Water repellent] [Lamination] <Insert description>.
   7. Pattern and Color: [Match Architect's samples] [As selected by Architect from manufacturer's full range] [As indicated in an awning schedule] <Insert color>.

B. Seam Thread: [100 percent expanded PTFE] [100 percent bonded polyester], UV-light, mildew, and rot resistant.

C. Decorative Trims: [Borders] [Braid and bindings] [Cords] [Fringe] [Patterned edge; scalloped] [Patterned edge; V-shaped] [Streamers] [Tassels] [Welting] <Insert description>.
   1. Colors: [As indicated by manufacturer's designations] [Match Architect's samples] [Matching or coordinating with awning fabric color] [As selected by Architect from manufacturer's full range] [As indicated in an awning schedule] <Insert colors>.

D. Fringe: [As indicated by manufacturer's designation for style and color] [As indicated in awning schedule] <Insert description>.

2.2 AWNING FRAME AND ACCESSORY MATERIALS

A. Steel:
   1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
   2. Steel Tubing: ASTM A500/A500M.
   3. Galvanized Steel Tubing: ASTM A787/A787M.
B. Aluminum: Alloy and temper recommended by awning manufacturer for type of use and finish indicated and with not less than the strength and durability properties of alloy and temper required by structural loads.
   1. Aluminum Plate and Sheet: ASTM B209.

C. Anchors, Fasteners, Fittings, Hardware, and Installation Accessories: Complying with performance requirements indicated and suitable for exposure conditions, supporting structure, anchoring substrates, and installation methods indicated. Corrosion-resistant or noncorrodible units; weather-resistant, compatible, nonstaining materials. Provide as required for awning assembly, mounting, and secure attachment. Number as needed to comply with performance requirements and to maintain uniform appearance; evenly spaced. Where exposed to view, provide finish and color as selected by Architect from manufacturer’s full range.
   2. Lag Bolts: ASME B18.2.1.
   3. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers, zinc coated.
   4. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing according to ASTM E488 conducted by a qualified independent testing and inspecting agency.
      a. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.
   5. Adhesive-Bonded Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing according to ASTM E1512 conducted by a qualified independent testing and inspecting agency.
      a. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.
   6. Grommets: [Zinc-coated brass, No. 2] [Stainless steel, No. 2] <Insert description>.
   7. Lacing: [100 percent polyester, braided No. 4] <Insert description>.


E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.3 AWNING FABRIC FABRICATION

A. Fabrication: Reinforce wear points and hardware attachment points with [nonwoven] [mesh] [polypropylene mesh] <Insert description> webbing. Seam fabrics [in locations indicated on the Drawings and] as follows:
   2. Fabric Edges and Seams: Hot cut and sealed.
   5. Fabric Edges and Seams: Manufacturer’s standard hemming and seaming methods.
   6. Fabric Attachment: [Manufacturer’s standard.] [Hem pockets.] [Screws.] [Staples.]
   7. Fabric Attachment: Grommets.
A. Grommet Spacing: [6 inches o.c.] <Insert spacing>.

B. Fabric Insets: [Heat-sealed] [Sewn-in] process.

C. Graphic Application: [Hand painting] [Silk-screen printing] [Heat color transfer] [Vinyl film with pressure-sensitive adhesive backing] [PVDF film with pressure-sensitive adhesive backing] [PVF film with pressure-sensitive adhesive backing] [Radio-frequency, heat-sealed vinyl film] [Eradication] [Cut-out lettering] <Insert description>.
1. Graphic Image: [As indicated on Drawings] [As indicated in awning schedule].
2. Text Message: [As indicated on Drawings] [As indicated in an awning schedule] <Insert text>.
   a. Text Font: [Helvetica] <Insert style>.
   b. Character Size: Minimum [1-inch] [1-foot] <Insert dimension> high characters.
   c. Character Colors: <Insert colors>.
3. Vinyl Film: [Calendered-vinyl film, not less than 3 mils thick, with pressure-sensitive adhesive backing] [Cast-vinyl film, not less than 2 mils thick, with pressure-sensitive adhesive backing] [Cast-vinyl reflective film, not less than 2 mils thick, with pressure-sensitive adhesive backing] <Insert description>.

2.4 FIXED AWNING FABRICATION

A. Frame Fabrication: Fabricate awning frames from [steel] [aluminum]. Preassemble in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

B. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

C. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Fabricate slip-fit connections exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

D. Weld corners and connections continuously. Obtain fusion without undercut or overlap. Remove welding flux immediately. At exposed corners and connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Provide for anchorages of type indicated; coordinate with supporting structure. Space anchoring devices to secure awnings in place and to properly transfer loads.

F. Steel Finish: [Galvanized mill finish; apply galvanizing repair paint to welds.] [Manufacturer's standard primed and top-coated decorative] [Baked-enamel or powder-coat] <Insert finish> finish complying with finish manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
   1. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.

G. Aluminum Finish: [Mill] [Manufacturer's standard primed and top-coated decorative] [Baked-enamel or powder-coat] <Insert finish> finish complying with finish manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
   1. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.
PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for supporting members, blocking, inserts, installation tolerances, [operational clearances, accurate locations of connections to building electrical system,][lighting,] and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install awnings[ and motor controls] at locations and in position indicated, securely connected to supports, free of rack, and in proper relation to adjacent construction. Use mounting methods of types described and in compliance with Shop Drawings and fabricator's written instructions.

B. Install awnings after other finishing operations, including joint sealing and painting, have been completed.

C. Slip fit frame connections accurately together to form hairline joints, and tighten to secure.

D. Weld frame connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
   1. Field Welding: Comply with the following requirements:
      a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
      b. Obtain fusion without undercut or overlap.
      c. Remove welding flux immediately.
      d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Anchoring to In-Place Construction: Use anchors, fasteners, fittings, hardware, and installation accessories where necessary for securing awnings to structural support and for properly transferring load to in-place construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come in contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

G. Coordinate awning installation with flashing and joint-sealant installation so these materials are installed in sequence and in a manner that prevents exterior moisture from passing through completed exterior wall and roof assemblies.

3.3 INSTALLED WORK

A. Adjust hardware and moving parts to function smoothly, and lubricate as recommended by retractable-awning manufacturer.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Galvanized Surfaces: Clean field welds, connections, and abraded areas and repair galvanizing to comply with ASTM A780.
END OF SECTION
SECTION 112326
COMMERCIAL WASHERS AND EXTRACTORS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Laundry Appliances
   1. Clothes washer (VOC EQ-11).
   2. Clothes dryer (VOC EQ-12).

1.2 SUBMITTALS
A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
B. Coordination Drawings: Indicate locations of laundry equipment and connections to utilities, and clearance requirements for equipment access and maintenance.
C. Operation and Maintenance Data: For laundry equipment to include in emergency, operation, and maintenance manuals. Include a schedule with the following:
   1. Designation indicated on Drawings.
   2. Manufacturer's name and model number.
   3. List of factory-authorized service agencies including their addresses and telephone numbers.

1.3 QUALITY ASSURANCE
A. Manufacturer Qualifications: Maintains a service center capable of providing training, parts, and emergency maintenance repairs.
B. Installer Qualifications: An employer of workers trained and approved by manufacturer for installation and maintenance of units required for this Project.

1.4 DELIVERY AND STORAGE
A. Deliver appliances to Project site in manufacturer's undamaged protective packaging.
B. Delay delivery of appliances until utility rough-in is complete and construction in spaces to receive appliances is substantially complete and ready for installation.

1.5 WARRANTIES
A. Submit written warranties executed by manufacturer of each appliance specified agreeing to repair or replace units or components that fail in materials or workmanship within specified warranty period.
B. Washer Extractor Parts Only: Manufacturer's standard form in which manufacturer agrees to repair or replace any part of the equipment assembly that fails within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion.
C. Dryer Tumbler Parts Only: Manufacturer's standard form in which manufacturer agrees to repair or replace any part of the equipment assembly that fails within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion.
PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS
   A. Regulatory Requirements: Comply with the following:
      1. NFPA: Provide electrical appliances listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
      2. ANSI: Provide gas-burning appliances that comply with ANSI Z21 Series standards.
      3. UL Certification: Provide electric equipment and components that are evaluated by UL for fire, and electric shock according to applicable safety standards and that are UL certified for compliance and labeled for intended use.
      5. NFPA 70 - National Electrical Code.
      7. Clothes Dryer: UL Listed.

2.2 PRODUCTS AND MANUFACTURERS
   A. Basis-of-Design Products: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:
      1. Alliance Laundry Systems.
      2. Dexter Laundry.
      4. Huebsch.
      5. Maytag.
      6. Speed Queen.
      7. Unimac.
      8. Whirlpool.
   B. (VOC EQ-11) Washer:
   C. (VOC EQ-12) Dryer/Extractor:

2.3 SOUND ISOLATION
   A. Isolate appliances from rigid contact with floor with Mason Type W neoprene pad mounts under feet.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.
   B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.
   C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
   D. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION, GENERAL
   A. General: Comply with manufacturer's written instructions.
   B. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
   C. Utilities: See Divisions 22 and 26 for plumbing and electrical requirements.

3.3 FIELD QUALITY CONTROL
   A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   B. Tests and Inspections:
      1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
      2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
      3. Operational Test: After installation, start units to confirm proper operation.
      4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.
   C. An appliance will be considered defective if it does not pass tests and inspections.
   D. Prepare test and inspection reports.

3.4 DEMONSTRATION
   A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain residential appliances.

END OF SECTION
SECTION 115700
VOCATIONAL SHOP EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. VOC EQ-1: Dust curtain.
   3. VOC EQ-3: Metal Dust Collector.
   4. VOC EQ-4: Metal Dust Collector Stand for Bench Grinder.
   7. VOC EQ-7: Wood Dust Collector, Portable.
   8. VOC EQ-8: Dye Vat.

B. Related Sections:
   1. Divisions 22, 23 & 26 specifications for equipment venting, gas and utility connections, power and controls.
   2. Division 26: For power and connections.

1.2 ACTION SUBMITTALS
A. Product Data: Manufacturer’s specifications and technical data including performance, construction and fabrication information.
B. Equipment Options and Accessories: Submit to Owner for approval prior to purchase of equipment.
C. Shop Drawings: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, including specific requirements indicated.
D. Dust Collector Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   2. Material gages and finishes, including color charts.
   3. Filter media. Type and area.

1.3 QUALITY ASSURANCE
A. Installer’s Qualifications: Firm with not less than 5 years experiences in installation of systems similar in complexity to those required for this Project, including specific requirements indicated.
   1. Acceptable to or licensed by manufacturer.
   2. Successfully completed not less than 5 comparable scale projects using this system.

1.4 DELIVERY, STORAGE, AND HANDLING
A. Packing and Shipping: Deliver products in original unopened packaging with legible manufacturer’s identification.
B. Storage and Protection: Comply with manufacturer’s recommendations.
C. Protect from damage by the elements and construction procedures.
1.5 **WARRANTY**

A. Manufacturer shall warrant installed system for a period of 5 years from Date of Substantial Completion.

B. Prior to purchase of specified equipment, coordinate equipment options and accessories with Owner.

1.6 **SERVICE CONTRACT**

A. Service Contract: Submit service contract to Owner in writing including separate cost of service contract and for 1 year service covering installed systems, which would commence immediately after expiration of warranty period, with separate costs for "on-call" service for in-house and in-shop work.

**PART 2 - PRODUCTS**

2.1 **EQUIPMENT REQUIREMENTS**

A. Electrical Equipment: Provide equipment suitable for use with electrical system indicated on drawings. Provide electrical components including motor, disconnect switches, motor controllers, motor control devices, electrical circuits, and connections which conform to requirements of NAPA 70, whether or not electrical items are furnished as part of the equipment components assemblies. Provide electrical wiring, conduit and electrical devices necessary for installation and operation of systems and equipment furnished.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. Manufactured Products: Manufacturer of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
   1. Components of assembled unit need not be products of single manufacturer.
   2. Constituent parts that are alike shall be products of single manufacturer.
   3. Components shall be compatible with each other and with total assembly for intended service.

E. Safety Devices: Fully enclose and guard exposed belts, chains, pulleys, couplings, shafts, gears, and other moving parts in accordance with ANSI pamphlet B15-1 irrespective of height above floor. Guards shall be of cast iron, sheet metal or wire mesh. Rigidly and suitable secure parts of guard so as to be readily removable without disassembling pipes and fittings on equipment.

2.2 **DUST CURTAIN**

A. Performance Requirements: NFPA fire-retardant, CFM fire-retardant.

B. (VOC EQ-1) Dust Curtain: Manually-operated.
   1. Basis of Design: Welding Curtain Walls by AKON, LLC.
   2. Layout: Straight.
      a. Total Height: 12 feet 0 inches.
      b. Bottom 48-inches opaque, middle 48-inches transparent, top 48-inches opaque.
      c. Chain-weighted bottom hem.
      d. Other Options: [Floor sweep] [Magnet seal] [Velcro seal] [Floor anchor straps]

C. Track: Manufacturer's suspended ceiling track, with threaded rod mounting.
2.3 SPRAY HOOD
   A. National Fire Protection Association (NFPA), Standard Number 33.
   C. (VOC EQ-2) Walk-in Spray Hood: Air is drawn in through the open face at the front of the spray booth; air flows through the booth's working area, into the exhaust plenum at the rear of the booth and then flows out to the atmosphere via the exhaust stacks. This booth is provided complete, with all necessary hardware.
      2. Interior Working Dimensions: 6'-0" wide X 7'-0" tall X 5'-0" long.
      3. Overall Dimensions: 6'-4" wide X 7'-2" tall X 7'-8" long.
      4. Panels: 18-gauge quality galvanized steel, flanged and precision punched on 6" centers for maximum rigidity. Panels are fastened together with 5/16" bolts and are to be sealed with the provided caulk following assembly.
      5. Integrated LED lighting: 4000 Lm; Fixtures are Maintenance-Free rated for Class I Division II Groups A, B, C, D; Class II Division II Groups F & G. Fixtures are ETL listed and approved for their intended use and placement. Lighting is provided by innovative LED technologies consisting of multiple high efficiency flux boards paired with high efficiency drivers. Fixtures are designed to accept either 120VAC or 277VAC power.
      6. Air Solenoid Valve: Interlocked to the exhaust fan and air supply for the spray application equipment
      7. NEMA 12 enclosure control panel that will house the disconnects, light switch, and fan control; single point connection.
   D. Spray Booth Fan: Aerovent No.BTABD.
      1. Volumetric Flow: 5250 CFM, at 0.5" Static Pressure.
      3. Horsepower: 1.0.

2.4 METAL DUST COLLECTORS
   A. (VOC EQ-3) Metal Dust Collector:
   B. (VOC EQ-4) Metal Dust Collector Stand for Bench Grinder:

2.5 WELDING FUME HOODS
   A. (VOC EQ-5) Wall-Mounted Welding Fume Hood:
      1. Basis of Design: Model SS-400-SKY by Sentry Air Systems, Inc..
   B. (VOC EQ-6) Portable Welding Fume Hood:

2.6 WOOD DUST COLLECTORS
   A. (VOC EQ-7) Portable Wood Dust Collectors:
      1. Basis of Design:
2.7 DYE VATS

A. (VOC EQ-8) Dye Vat: Self-contained, stainless steel, steam jacketed unit; electrical heated steam source within unit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

3.3 INSTALLED WORK

A. Adjust: Make necessary adjustments of equipment to ensure smooth and accurate operation.

B. Demonstration: Engage a factory service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment.
   1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
   2. Review data in maintenance manuals. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION
## THEATRICAL RIGGING LOOSE EQUIPMENT

<table>
<thead>
<tr>
<th>ITEM #</th>
<th>ITEM DESCRIPTION</th>
<th>PROSCENIUM THEATRE</th>
<th>BLACK BOX THEATRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Loose Blocks - Gridiron mounted, single groove for 3/4&quot; rope, 8&quot; dia., rope rigging block with j-bolt mounting hardware</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Rope - 600' spool of Multiline II, black, 3/4&quot; first grade, filament and stale/spun polyester wrapped fibrillated polyolefin.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cable Cradles - steel cable cradle for one multiconductor cable.</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Wood Belaying Pins - 21&quot; long by 1-5/32&quot; diameter with shoulder and handgrip, turned from hardwood.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Loose pipe - 21' long, 1.5&quot; I.D. schedule 40, black, steel pipe, drilled for pipe splice at both ends with protective caps</td>
<td>6 16</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Pipe splices - 18&quot; long, as shown on drawings for connection of pipes listed above with hardware</td>
<td>4 8</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Stingers - 7' long, 3/8&quot; wire rope, temporary pipe hanger, Light Source Unibolt unistrut channel nut, eye bolt, shackle, to full pipe clamp with turnbuckle</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

END OF SECTION 116133 - APPENDIX A
SECTION 116133
THEATRICAL RIGGING

PART 1 - GENERAL

1.1 SUMMARY

A. The work in this section includes Theatrical Rigging (TR) systems and equipment within the following spaces and associated support areas:
   1. Proscenium Theatre
   2. Black Box Theatre
   3. Valade Jazz Center

B. Section Includes
   1. Major Systems and Equipment: furnish and install the following major elements and associated accessories:
      a. Counterweight Rigging System
      b. Proscenium safety curtain with lineshaft winch
      c. Stage Traveler Track assemblies
      d. Rope rigging for multi-cable management
      e. Zero fleet hoist
      f. Rigging Control System
      g. Capstan winch
      h. Walk-Draw Drapery Track
      i. Houselight Rigging and cable management
      j. Tension wire grid
      k. Miscellaneous rigging equipment and accessories
      l. Main Drape and Valance
      m. Walk-draw acoustic draperies
      n. Drapery storage bags/hampers
      o. Fabric remnants from the manufacture of the theatrical draperies
      p. Site survey of existing conditions - Valade Jazz Center

2. Work Results:
   a. The equipment installed as part of this Section shall result in a complete and working theatrical rigging system.
   b. Provide fully coordinated and engineered equipment, installation, supervision and commissioning for systems and associated accessories as required for each space.
   c. Provide supervision of Theatrical Rigging Systems low voltage signal cable pulling, termination and testing by the Division 26 Electrical Contractor.
   d. Provide coordination of conduit, backboxes and AC power wiring provided by the Division 26 Electrical Contractor.
   e. Provide all material, components, accessories and services required to provide the work as specified herein, elsewhere in the Contract Documents and/or as shown on related drawings.
   f. Consult and coordinate with other affected work and contractors throughout the course of the work contained herein.

3. Delegated Design:
   a. Provide design for the means of fastening, suspension and support of the work of this Section.
b. Provide all material, components, accessories and services required to provide the work as specified herein, elsewhere in the Contract Documents and/or as shown on related Drawings.

C. Products Supplied But Not Installed Under This Section
   1. The following equipment supplied under this Section shall be installed and/or terminated under Division 26:
      a. Stage Level LED index strip light
      b. Motor Control Centers (MCC)
      c. Motion Control Racks (MCR)
      d. Rigging control system devices including but not limited to control panels, limit switches, detection and safety devices
      e. Low Voltage/Control Wireways for automated hoists
      f. Line Voltage Wireways for automated hoists
   2. Termination of control system conductors shall be made by Division 26 under the direct onsite supervision of the Contractor.
   3. If not internal to the equipment, controls, safety and limit switch devices are installed under this Section. Final terminations to the devices are made under Division 26.

D. Related Requirements
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications apply to this Section.
   2. Examine Contract Documents for requirements that directly affect or are affected by work of this Section. A list of those Documents and Sections includes, but is not limited to the following:
      a. Division 01 – General Requirements
      b. Division 03 – Concrete
      c. Division 04 – Masonry
      d. Division 05 – Metals
      e. Division 09 – Finishes
      f. Division 11 – Equipment
         1) Section 116135 – Stage Extension Orchestra Pit Lift System
         2) Section 116163 – Theatrical Lighting Dimming and Control
      g. Division 21 – Fire Suppression
      h. Division 22 – Plumbing
      i. Division 23 – Heating, Ventilating and Air Conditioning
      j. Division 26 – Electrical
         1) Section 265561 – Theatrical Systems Electrical Requirements
         2) General requirements for all Electrical work, including installation of system cable trays, terminal cabinets, empty conduit, junction/pull boxes and back boxes for system devices and panels (Division 26).
         3) Electrical terminations (AC power and grounding only) to all equipment racks and AC power receptacles (Division 26).
         4) Provision and installation of all conduit and back boxes (Division 26).
         5) Electrical services and main circuit protection (Division 26).
         6) Distribution system equipment (Division 26).
         7) Conduit, wire, pull boxes, junction boxes and miscellaneous hardware and components as required for a complete electrical installation.
         8) Terminations and testing of system continuity.
      k. Division 27 – Communications
         1) Structured cabling systems
         2) At common facility panels, coordinate receptacles for building standard communications systems.
      l. Division 28 – Electronic Safety and Security
1.2 PRICE AND PAYMENT PROCEDURES

A. Refer to Division 01 – General Requirements for information regarding price and payment procedures.

B. Unit Prices
   1. Provide price to Owner for five year maintenance agreement on winches. Price to include emergency site service (post warranty period), one one-day session of additional operator training per year, and replacement of parts due to failure under normal usage.

C. Alternates
   1. Provide separate price information to deduct the material and labor associated with the following equipment and systems from the price of the full and complete systems as otherwise specified in this document:
      a. Alternate #9 - Valade Jazz Center – Delete Cyclorama motorized batten and related infrastructure

1.3 REFERENCES

A. Abbreviations:
   1. The following abbreviations and acronyms are relevant to this Section and are in addition to those defined in Division 01 – General Requirements:
      a. ETCP – Entertainment Technician Certification Program.
      b. MCC – Motor Control Center
      c. MCR – Motion Control Rack
      d. SWL – Safe Working Load

B. Definitions:
   1. The following definitions are relevant to this Section and are in addition to those defined in Division 01 – General Requirements:
      a. In all cases where a device or a part of equipment is referred to in a singular manner within the contract documents, it is intended that such a reference shall include all devices required to complete the installation in accordance with the project documents.
      b. “Architect”: All references to the “Architect”, Hamilton Anderson Associates, will refer to the process by which the indicated action or decision regarding the work in this section will be administered. All such actions shall be initiated with or by the Architect, who will disseminate all pertinent information and documents to, as well as coordinate all efforts and site visits with, the Theatre Consultant and all other project consultants who may have design responsibility relating to the work in this section.
      c. “Theatre Consultant”: Auerbach + Associates, Inc. (d.b.a. Auerbach Pollock Friedlander). The Theatre Consultant will be party to all actions and decisions regarding the work in this section.
      d. “Other Project Consultants”: Acoustical Consultant, Electrical Engineer, Structural Engineer, or Mechanical Engineer as is applicable to a particular issue.
      e. “Contractor”: Manufacturer / Installer responsible for the fabrication and installation of the work contained in this section.
      f. Contractors involved with other work shall be indicated with a specific trade preceding the word “Contractor” (i.e. General, Electrical, etc.).
      g. “Owner”: Authorized personnel representing Wayne State University.
      h. “Furnish”: Purchase and/or fabricate and deliver to project site.
      i. “Install”: Physically install the items in their proper location(s) on the project site.
      j. “Provide”: Furnish and install.
2. Definitions of Technical Terms:
   a. “Safe Working Load”: The load that can be applied to the system by the end user.
   b. “System Load”: Sum of the Safe Working Load and the weight of the load carrying
device. The maximum load which can be safely handled by the machinery
installation under normal operating conditions, not taking dynamic forces into
consideration.
   c. “Dynamic Force”: Forces exerted on the structure or machine that are the result of
   the movement patterns of the load and system component parts.
   d. “Design Load”: Sum of the System Load and the loads due to dynamic forces.
   e. “Category 0 Stop”: An uncontrolled stop resulting from loss of power to the machine
   actuators at any time during its movement.
   f. “Category 1 Stop”: A controlled stop that allows power to the machine actuators to
   achieve a safe stop, and then removes power from the machine actuators when the
   stop is achieved.
   g. “Category 2 Stop”: A controlled stop that leaves power left available to the machine
   actuators.
   h. “Initial Limit”: The mechanical limit switch connected to the electrical system in such
   a manner as to prevent further movement in the over travel direction. It shall be a
   Category 2 stop and allow the user to operate the system in the opposite direction.
   i. “Ultimate Limit”: The mechanical limit switch is a positive break mechanical limit
   switch, which executes a Category 1 stop. NOTE: The Ultimate Limit switch shall
   be located in such a manner that, should the Initial Limit fail to operate, if the
   machinery strikes the Ultimate Limit at maximum speed all components of the
   machine shall come to a complete stop before the over travel results in mechanical
damage.
   j. “Fleet Angle”: The angle formed between the wire rope and the centerline of a
   sheave or drum as the wire rope traverses to another sheave or fixed point.
   k. “Zero Fleet Winch”: A hoist in which the line pays off the drum at the exact same
   location at all times, thereby maintaining a fleet angle of zero (0) degrees.

C. Reference Standards:
   1. Reference Division 01 for general project references and standards.
   2. References to codes, standards, specifications and recommendations of technical
   societies, trade organizations and governmental agencies will refer to the latest edition
   of such publications adopted and published prior to submittal of the bid. All such codes
   and standards will be considered a part of this specification as if they were fully included
   herein.
   3. If an applicable code or standard permits work of lesser quality or extent than this
   specification, then this specification and the related drawings will govern.
   4. Comply with national, state and local codes.
   5. Comply with national, state and local labor regulations and requirements.
   6. The following standards apply to the work of this Section. It remains the Contractor’s
   responsibility to confirm and comply with all industry standards that are applicable to the
   work of this Section.
   a. ASTM International
      1) ASTM A36 for structural steel shapes
      2) ASTM A47 for malleable iron casting
      3) ASTM A48 for gray iron casting
      4) ASTM A1011 for side plates
   b. American National Standards Institute (ANSI):
      1) ANSI B18.2.1&2 for square and hex bolts and nuts
      2) ANSI-Z535 – System load and safety signage
      3) ANSI E1.6-1 Entertainment Technology – Powered Hoist Systems
      4) ANSI E1.4-1 Entertainment Technology – Manual Counterweight Rigging
       Systems
5) ANSI E1.22 Entertainment Technology – Fire Safety Curtain Systems
   c. American Iron and Steel Institute (AISI):
      1) AISI 1045 for steel shafts
   d. National Fire Protection Association (NFPA)
      1) NFPA 70 - National Electrical Code
      2) NFPA 80 – Standard for Fire Doors and Other Opening Protectives
   e. National Electrical Manufacturers Association (NEMA)
      1) NEMA WC 63.1 (2005) Twisted Pair Premise Voice and Data Communications Cables
      2) NEMA WC 66 (2001;Errata 2003) Category 6 and Category 7 100 Ohm Shielded and Unshielded Twisted Pairs
   f. Underwriters Laboratories Incorporated (UL)
      1) UL/IEC 61508A Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems
      2) UL 1666 (2000; Rev thru Jul 2002) Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

1.4 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. The Contractor is required through drawings, memos and meetings to properly coordinate the work with the other sections as necessary to complete the work of this section.
   B. Pre-installation Meeting:
      1. Refer to Division 01 - General Requirements for information regarding pre-installation meeting with the General Contractor.
   C. Sequencing
      1. The installation of the equipment in this section shall be coordinated with other work which may be in conflict with or which must be completed before the work in this section may be installed, including:
         a. Principal foundation work (see Architectural Drawings)
         b. Installation of associated electrical work (see Electrical Drawings)
         c. Installation of HVAC work in ceilings (see Mechanical Drawings)
         d. Painting
         e. Finishing of floors and finishes
         f. Electromechanical and electronic equipment installation shall proceed after environmental site conditions are met. Refer to paragraph 1.10-B for class requirements.

1.5 ACTION SUBMITTALS
   A. All submittals shall be submitted in accordance with Division 01.
   B. All submittals shall be submitted in a timely manner, allowing sufficient time for adequate review and possible resubmittals without jeopardizing project schedule.
   C. Submittals will be reviewed, accepted and field dimension verified prior to proceeding with the fabrication of the work in this section.
D. All submittals shall leave space available for review stamps and comments.

E. The Architect and Theatre Consultant shall only mark one set of drawings per submittal with comments. Any additional sets of drawings or product data shall be returned unmarked.

F. Provide insurance against loss or damage during shipment. Furnish certifications of such coverage to the General Contractor not less than 60 calendar days prior to the shipment of any equipment.

G. Review all pertinent project Contract Documents. Following this review, provide to the Architect and General Contractor any additional information required to make a fully functioning system. In addition, the Manufacturer shall indicate maximum accepted wire size as it relates to termination points on their equipment.

H. Verify wire type, count, and routing for all required data wiring between all components to allow for proper conduit sizing and routing by Division 26. Verify and coordinate all line voltage power input required by systems components that shall be provided under Division 26.

I. Prior to fabrication, it shall be the responsibility of the contractor to provide a complete submittal for approval within 90 days of award of contract.

J. Product Data
   1. Where standard manufacturer parts are used, submit current product literature describing component, manufacturer’s recommended applications, load ratings, safety factors and dimensions. The data shall include all information which indicates compliance with the specifications herein.
   2. Clearly indicate specific component and applicable options.

K. Shop Drawings
   1. Provide shop drawings on D size minimum (24” x 36”) sheets.
   2. Include a cover sheet with a drawing index including sheet number and title for each sheet in the set.
   3. Provide ½” = 1'-0” plans of all locations which contain equipment in this contract. Show all equipment properly located, dimensioned and labeled. Note all work by others in the vicinity which may affect work of this Section.
   4. Provide complete, fully dimensioned, large scale detailed fabrication drawings of all major components.
   5. Provide requisite schematics, plans and sections indicating assembly and installation of components.
   6. Provide indications by arrow and boxed caption of all variations from contract drawings and specifications, except where variation is indicated as acceptable.
   7. Indicate all elements with appropriate safety factors and/or safety equipment.
   8. Indicate recommended load limits for each element in the system with loading requirements.
   9. Indicate Safe Working Load for each element in the system with loading requirements.
   10. Provide power requirements, one-line riser diagrams and installation circuit diagrams for electrical equipment. Show all required wire sizes and counts between all components. These shall be provided within 30 days of Contract Award.
   11. Provide a full Bill of Materials to be supplied, including quantities, manufacturer’s part number, reference to applicable drawings, etc.
   12. Provide an inventory of all draperies to be supplied, indicating fabric type, fullness, edge finish, color and size.

L. Samples
   1. Submit sample items including, but not limited to:
a. Submit 24” x 24” Tension Wire Grid module as a full scale mock-up of all components including:
   1) Perimeter channel painted to display finished painted surfaces
   2) Cable with typical connection hardware.
   3) Finished cable holes
b. Full bolt-width (54”) by 36-inch “quality” samples and color line swatches for all fabrics to be selected “by Architect”. These samples will be approved and all colors selected prior to shop drawings submittals.
c. Samples of standard hooks, swivels, ties and hardware.
d. Samples of drapery tracks and associated hardware.
e. Control switches and panel materials.
2. Additional samples must be submitted within 14 days of Architect’s written request.

M. Certificates
1. Provide a Certificate of Training for each participant at the conclusion of Owner instruction sessions.
2. Provide manufacturer’s certificates stating drapery materials meet fire performance characteristics as specified herein.
3. Provide manufacturer’s certificates stating prosenium safety curtain materials meet fire performance characteristics as specified herein.

N. Delegated Design Submittals
1. Provide drawings and calculations meeting the review requirements of the authorities having jurisdiction, stamped and wet signed by a Professional Engineer licensed in the project jurisdiction for work of the specific type performed.
2. Engineered drawings shall be provided to the Architect and Theatre Consultant for review of coordination and compliance to this Section.
3. Engineered drawings shall be provided to the Structural Engineer of record for this project. The engineer of record will review the loads imposed on the structure by this equipment and compare those loads to allowable structural loading.
4. Engineered drawings shall be provided to the Authority Having Jurisdiction for this facility. The AHJ will review the drawings for compliance with local codes. In all cases code compliance is the responsibility of the Contractor.

O. Test and Evaluation Reports
1. Test Procedures
   a. Provide test procedures for all custom motor drive assemblies.
   b. The test procedures shall describe in detail all of the necessary operations to perform verification through a test. A test procedure shall be produced for every verification test required and shall contain the following information:
      1) Scope of the test: the test shall be described and the intended result shall be listed.
      2) Application Documents: all the documents referred to in the test procedure shall be listed.
      3) Test conditions: all applicable requirements needed to correctly perform the test shall be listed and detailed (for example: special environmental conditions, dedicated tools, test rigs, special requirements on the tested items, calibration requirements, etc.)
      4) Test procedure: all operations required to perform the test shall be detailed.
      5) Test results presentation: the procedures to process the raw data for final presentation of the test results shall be described.
2. Test Reports
   a. Winches: Provide a load testing report for every winch and component part installed in the automated system based on Safe Working Load.
      1) Static loading of primary brake to 1.25 x SWL for a minimum of 10 minutes
2) Static loading of secondary brake to 1.25 x SWL for a minimum of 10 minutes
3) Dynamic test of primary brake to 1.0 x SWL (drop test)
4) Dynamic test of secondary brake to 1.0 x SWL (drop test)
5) Full speed E-Stop test with 1.0 x SWL
6) Test all limits at full speed with 1.0 x SWL

P. Source Quality Control Submittals
   1. The Contractor shall supply as part of the submittal process the following Source Quality
      Control documents which must contain, at minimum:
      a. Serial number of hoist
      b. Motor drive serial number
      c. Batch number of major components
      d. Name of person conducting the QC test
      e. Date the test was conducted
      f. List of mechanical tests conducted
      g. List of electrical tests conducted

Q. Special Procedure Submittals
   1. Installation/Erection Plan
      a. The Contractor shall supply as part of the submittal process the following
         Installation/Erection Plan documents which must contain, at minimum:
         1) Required path to site of work, including maximum loads applied to floor in that
            path
         2) Maximum size and weight of pieces to be moved along the path
         3) Required erection machinery, including lifts, hoists, etc., including the
            maximum loads applied to the floor and lift points in the erection area
         4) Erection Plan: the plan shall outline the construction methods, erection
            sequence, erection bracing, temporary bracing if required, equipment
            required and other engineering details necessary for shipping, erecting and
            maintaining stability of the equipment detailed in this section
   2. Training
      a. To ensure proper training of the user group, the Contractor shall supply as part of
         the submittal process the following training documentation:
         1) Training syllabus
         2) Training guide (bound hard copy)
         3) Training guide (hands on system training)
         4) Testing document for confirmation of understanding
         5) DVD/ MPG video training file
      b. These shall be provided two (2) months prior to completion.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents:
   1. Submit documents in accordance with Division 01 – General Requirements
   2. At the time of acceptance testing, submit three (3) copies of parts lists and maintenance
      instruction sheets.
   3. Within 60 days of acceptance testing, submit one (1) set of reproducible “as built and
      approved” drawings showing all equipment as installed. These drawings shall include
      all adjustments made during the checkout process.
   4. Submit operation and maintenance manuals with the “as built and approved” drawings.
      Each manual shall be bound in an individual binder with the project name on the front
      cover and system identification on the spine. The manuals shall include:
      a. Complete parts list for all equipment and telephone numbers for the authorized parts
         and service distributors.
b. Instructions as to the safe operation for all equipment.
c. Recommended maintenance schedule for component parts that may need periodic replacement or maintenance.
d. Recommendations for cleaning, maintaining and touch-up of all finished surfaces.
e. Provide specific recommendations for cleaning drapery fabric, including precautions against materials and methods which could damage drapery fabric.
f. Deliver all copies of approved Operations Manual to Owner during instruction session, and review it as part of that session.

5. Where specific elements do not require manuals, instruction sheets as to care and handling shall be provided.

6. Certificates of flame resistance as required herein.

7. Warranties as required herein.

B. Maintenance Contract
   1. Refer to 3.10 – Maintenance.
   2. Submit maintenance contract proposal for Owner and Theatre Consultant review no later than one month prior to substantial completion.

C. Submit verification that all punch list items have been rectified. Such written verification will be required for project closeout and initiation of the warranty period.

D. The record documents shall be reviewed by the Architect and all modifications to the documents stemming from this review shall be made as required.

E. Above submissions are required as a condition for final approval of the work.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts
   1. Furnish the following user-serviceable components as spare parts for major electronics assemblies:
      a. Furnish 3 spare fuses of each type in the system
      b. Furnish 1 spare breaker of each type in the system
      c. Furnish 4 spare keys of each type in the system
      d. Furnish 1 spare sets of winch control connection cables
      e. Furnish 1 spare e-stop master controller card
      f. Furnish 1 spare winch drive motion controller card
   2. Motors and complete motor drives shall not be provided but shall be available within 24-hours of notice to manufacturer.

B. Extra Stock Materials:
   1. Deliver stock of maintenance material to Owner. Furnish the following to match those installed and taken from the same production run, packaged with protective covering for storage and identified with appropriate labels:
      a. Furnish 12 compression sleeves of each type in the system.
      b. Furnish 4 shackles of each type in the system.
      c. Furnish 12 thimbles of each type in the system.
      d. Furnish 12 bolts and nylock nuts of each type in the system.
      e. Furnish 12 lockwashers of each type in the system.
      f. Furnish 4 turnbuckles of each type in the system.
      g. Furnish 1 master track carrier of each type in the system.
      h. Furnish 4 other track carriers of each type in the system.
   2. Deliver all fabric remnants from the manufacture of the theatrical draperies to the Owner.
1.8 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Refer to Division 01 – General Requirements.

B. Qualifications
   1. All equipment and installation to be the responsibility of a single Contractor, who shall own and operate their own manufacturing facility for the fabrication, assembly and integration of theatrical rigging equipment, and be regularly engaged in the fabrication of such equipment. Fabrication of such equipment shall comprise no less than 90% of the Contractor’s business.
   2. The Contractor’s Project Manager shall be qualified and have experience in projects of similar size and scope. The Project Manager shall have binding authority to represent and act for the Contractor. The Project Manager shall be the primary conduit for all information between the supplier of this equipment and the General Contractor. All information given to the Project Manager shall be considered as given to the Contractor.
   3. The Contractor shall have been continuously engaged in the fabrication, integration and installation of theatrical rigging systems for no less than five years.
   4. The Contractor shall have, at the time of bid, a current Contractor’s License and shall know, understand, and have the required documentation to work in the State of Michigan. This license shall be maintained throughout the course of work of this contract.
   5. Contractor is responsible for proper installation, operation and safety of all component equipment.
      a. Equipment must be procured as specified. Non-specified items may be procured from any nationally recognized manufacturer.
      b. Metalworking may be done by others. Responsibility in all respects shall be that of the Contractor.
   6. The Contractor shall verify all system design loads.
   7. Errors and omissions within the Contract Documents shall not relieve the Contractor and the General Contractor of the responsibility for providing a properly functioning installation of the system as described herein.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage and handling shall be coordinated with the General Contractor and shall meet all requirements described in Division 01.

B. Packing, Shipping, Handling and Unloading
   1. All equipment shall be appropriately and substantially packed for shipment.
   2. All equipment containers shall clearly indicate the equipment contained, “front”, “top”, “fragile”, the project name, and theatre site allocation. Include packing and shipping lists for each container.
   3. All drapery shall be boxed in solid plywood crates and shipped on pallets. In no case shall the drapery itself contact any slatted surfaces during shipping.
      a. All required weights and bottom pipe to be shipped separately from draperies and installed on the job site.
   4. All shipping costs to the job site are the responsibility of the Contractor. The shipping method/company is at the total discretion of the Contractor in order to meet the published project schedules.

C. Acceptance at Site
   1. Coordinate responsibility for acceptance of material and equipment at job site with the General Contractor.
2. The Contractor shall be responsible for acceptance of the Theatrical Rigging System components at the job site, confirming that all quantities and counts are correct and for keeping accurate logs and records of such information.

D. Storage and Protection
1. Upon delivery, the materials shall be stored under cover in a clean and dry location, off the ground. Delivered materials which are damaged or otherwise not suitable for installation shall be removed from the job site and replaced with acceptable materials.
2. Replace, at no additional expense to the Owner, all equipment and materials which are damaged during storage or handling.

1.10 SITE CONDITIONS
A. Existing Conditions
1. Verify all conditions at job site. Promptly report variations and obstructions to the Architect. All additions and/or corrections are to be requested prior to fabrication.

B. Environmental Requirements
1. Equipment is classified according to its susceptibility to construction conditions that may affect its operation. Classes shall be defined by the following paragraphs:
   a. Class 1:
      1) Cable and distribution apparatus, structural elements, electrical back boxes, face plates, terminal boxes, and empty equipment rack frames may be stored in weather protected spaces under "normal" construction site conditions provided that no electronic components are contained within devices, storage boxes are sturdy and well-sealed, and equipment is protected with imperforate inner plastic sheeting.
      2) Contractor may install this class of equipment in weather-protected spaces under "normal" construction site conditions provided that equipment is protected from dust and moisture by sturdy imperforate plastic sheeting and completely covered with corrugated cardboard held securely in place by duct tape. Cardboard covers shall not be removed until area is broom cleaned. Under no circumstances shall equipment remain uncovered overnight during installation or while work which causes high dust or moisture levels in area of placement is taking place.
   b. Class 2:
      1) Control panels, spare parts, test and other equipment (except as listed under Class 3) not subject to damage by concrete dust or dirt shall be stored and protected per Class 1 devices.
      2) Contractor shall not install equipment in this class until area of installation is broom cleaned, "blown" clean with pressurized air, mopped, air conditioned and secure. Contractor may install control panels with electronic components under Class 1 conditions, but electronic components must be removed and not installed until area of installation meets Class 2 conditions.
   c. Class 3:
      1) Control consoles, filled equipment racks and other electronic equipment shall not be shipped to site until the rack and control rooms are finished, air conditioned, dust free, broom and mop cleaned, secure, and in all respects complete and ready for occupation.
      2) This class of equipment shall not be unpacked until the system is complete in all other respects. Under no circumstances may any equipment in this class be removed from the rack and control rooms into or through spaces which are not cleaned, air conditioned, and complete.
C. Field Measurements
   1. Field measurements shall be taken prior to preparation of final shop drawings and prior to fabrication to ensure proper fitting of work. Allow for adjustments during installation whenever taking field measurements.
   2. Should field measurement of site conditions alter the design or installation of system elements from the approved shop drawings, revised shop drawings shall be reissued for review.

1.11 WARRANTY

A. Comply with the warranty requirements of Division 01 and the following.

B. The Contractor shall warrant materials and workmanship of systems and equipment installed as free of defects. The Contractor shall guarantee in writing the repair or replacement within 14 days of any item found defective during a period of one (1) year following date of final acceptance. Ordinary wear and defects due to improper usage are excepted.

C. The Contractor shall warrant the workmanship of the installation services provided under this Section for a period of one (1) year following the date of final acceptance. Ordinary wear and damage due to improper usage are excepted.

D. During the warranty period, all emergency conditions where systems failures may be hazardous or may cause severe hardship or cancellation of performances shall be responded to within 24 hours. Immediate action shall be undertaken to ensure the safety of the audience and the performers.

E. During the Warranty Period, for each product that uses software, furnish manufacturer’s software updates to the Owner for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. To establish comparative standards of quality, the Contractor may install elements as manufactured by the following, or an approved equal:
   1. Counterweight Rigging Systems
      a. H & H Specialties Inc.
      b. J.R. Clancy, Inc.
      c. Thern Stage Equipment
      d. Texas Scenic Company
   2. Track Systems
      a. H & H Specialties Inc.
      b. Automatic Devices Company (ADC)
      c. Gerriets
      d. Triple E
   3. Motorized Zero-Fleet Hoist
      a. J.R. Clancy, Inc.
      b. ETC Rigging
   4. Motorized Rigging Control Systems
      a. J.R. Clancy, Inc.
      b. ETC Rigging
5. Draperies
   b. iWeiss
   c. Rose Brand
   d. Stage Decoration and Supplies

B. Manufacturers shall provide the Warranty and Maintenance services specified herein as applicable to their products.

C. Manufacturers shall engineer, design, produce shop drawings and fabricate all custom equipment required in this section.

2.2 SYSTEMS DESCRIPTION

A. The following performance spaces shall contain the following major system components listed below and as shown on the TR-series drawings:

1. Proscenium Theatre
   a. Counterweight System:
      1) Structural performance for this entire system must be fully documented under the direct supervision of a Structural Engineer registered in the State of Michigan. The Contractor’s engineer shall design and/or select all elements and their connections to meet or exceed the International Building Code.
      2) The rigging system shall include provisions for basic hanging, shifting and storing of scenery, stage draperies, masking and elements of the stage lighting systems.
      3) The rigging system is highly integrated with the structural steel of the fly tower. See structural Drawings and Specifications for details.
      4) The counterweight system shall be a single purchase, “tee” bar guide as detailed in the drawings. See drawings for layout. Operation of the counterweight system shall be from locking rail on the stage floor. The battens shall travel as indicated on the drawings.
      5) The technical galleries at stage left and right shall permit the random use of rope line rigging to be spotted on the gridiron at any point above the stage. The loading gallery shall provide access to the counterweight arbors when a batten is being loaded.
   
   b. Proscenium Safety Curtain
      1) Straight lift proscenium safety curtain with lineshaft winch, smoke pocket, pull station, rate of rise detector, fusible links, and associated hardware.
      2) Provide push-button controls for non-emergency operation.
   
   c. Cable Management systems
      1) Cable cradles, manual hemp lines, and floor mounted hemp blocks will be included for management of electrical multi-cables.
   
   d. Portable Capstan Winch
   
   e. Stage Traveler Track assemblies
      1) Main Drape traveler track shall be furnished for manual, bi-parting, back-packing curtains.
   
   f. Main Drape and Valance
   
   g. Acoustic Drapery Track
      1) Walk-draw track assembly
   
   h. Walk-draw acoustic drapery
   
   i. House Light Rigging

2. Black Box Theatre
   a. Tension Wire Grid
   b. Demountable dead hung drapery pipe battens
3. Valade Jazz Center
   a. Site survey of existing conditions
   b. Zero Fleet Motorized Batten System
   c. Rigging Control System
   d. Acoustic Traveler Track assemblies
      1) Acoustic backdrop drape traveler track shall be furnished for manual, bi-
         parting, back-packing curtains.
   e. Acoustic bi-part drapery

B. State of the Art Development
   1. The Contractor shall furnish only the manufacturer’s latest developed appropriate
      products. In cases where product development from a specified manufacturer surpasses
      the criteria of this specification, the Contractor shall inform the Architect and make the
      newer product available to the Owner for acceptance. In no case shall discontinued or
      obsolete equipment be acceptable. Should a newer product be suggested as a
      substitution for a discontinued product, or for a product that is in process of being phased
      out of production, that newer product shall be offered to the Owner at no additional cost.
   2. Should product recall by the Manufacturer require temporary or permanent replacement
      of a product specified under this section, the Contractor shall notify the Owner at the
      earliest reasonable time and shall arrange to replace the product in question at the
      earliest possible time.
   3. Equipment found defective or subject to recall prior to scheduled installation shall not
      be delivered to the job site.
   4. Equipment defect or intended recall shall not relieve the Contractor from his contractual
      obligation with regard to delivery schedule of product. In this circumstance, notification
      shall be made to the Architect by express carrier. Arrangement for alternate product
      shall be made at this time.

C. Substitutions
   1. All requests for variations from the specified materials and products will be reviewed by
      the Architect according to the procedures outlined in Division 01.
   2. All requests for substitutions must be submitted in a timely manner, so as not to
      adversely impact the project schedule.
   3. Substitutions will only be accepted if, in the opinion of the Architect, the product is an
      equal to the specified product. No substitutions may be made without written acceptance
      from the Architect. All substitutions made prior to this acceptance are at the sole risk of
      the Contractor.
   4. A substitution must be a product of equal design, construction and performance. The
      Contractor must submit all pertinent information required to substantiate that the product
      is equal. The Contractor must submit all additional information, including test data, which
      may be requested in order for the Architect to fully evaluate the substitution. The burden
      of proof is solely on the Contractor.
   5. All additional expenses of any kind with respect to substitution(s) shall be borne by the
      Contractor. This shall include, but not be limited to, all fees and expenses incurred by
      the Architect and other related Consultants for evaluation of the substitution and
      subsequent integration into the project should the substitution be taken and/or additional
      costs of other contractors related to the substitution(s).

2.3 MATERIALS

A. General
   1. All equipment and components shall be new and complete. No used or reconditioned
      equipment shall be acceptable unless otherwise noted.
   2. All equipment to have pertinent labels.
B. Materials shall conform to the following minimum standard specifications:
   1. AISI 1045 for steel shafts
   2. ASTM A36 for structural steel shapes
   3. ASTM A47 for malleable iron casting
   4. ASTM A48 for gray iron casting
   5. ASTM A1011 for side plates
   6. ANSI B18.2.1&2 for square and hex bolts and nuts

C. Hardware
   1. All mounting hardware to be included.
   2. All bolts and fasteners must be Grade 5 or better.
   3. All bolted attachments to have lock washers or other self-locking fasteners.

D. Electrical
   1. All internal wiring shall be factory completed and clearly marked. All field connections
      shall be by compression connector, terminal strip or other device specified herein. All
      terminal strip connections shall be clearly labeled as to terminal designation. Insulated
      wire ferrules are to be used whenever possible for wire termination. Wire nut splices not
      permitted.
   2. All wire sizes and insulation to comply with Underwriters Laboratory and all applicable
      standards and local codes.
   3. All wiring to be harnessed and bound. No loose or randomly routed wires shall be
      permitted.

E. Design Factors
   1. Overhead rigging elements to be designed with a mechanical safety factor of their
      minimum breaking strength.
      a. Wire rope: 8:1
      b. Terminating hardware: 5:1
      c. Batten clamps: 5:1
   2. All drive components shall be designed with a safety factor 3X.
   3. Bearings shall be designed with a 2X rating, full speed / 2000 hours.

2.4 COUNTERWEIGHT RIGGING SYSTEM

A. Tee Bar Guide Tracks
   1. Provide “tee” bar guide tracks installed on the tee bar wall from the stage floor to the
      underside of the headblock beam, as indicated on the Drawings. The center-to-center
      dimension (in plan) between each tee bar varies, refer to the Drawings. The tee bar
      must form a true vertical plane and be so certified by the Contractor. All splice joints
      shall be free of burrs and irregularities and in exact alignment.
   2. Provide tee bars of 2" x 2" x ¼" steel tee, held in place by spreader "U" plates bolted to
      continuous horizontal steel angle wall battens fastened to continuous horizontal Unistrut,
      Superstrut, or equal on 5'-0" maximum vertical centers over the entire length and height
      of the system, and held in place by 2-3/8" x 5/16" bent steel plate wall knees. Finish flat
      black. See Structural Drawings and coordinate for exact locations of wall attachment.
   3. 
   4. Provide continuous floor batten and continuous top and bottom stop batten of 2" x 2" x
      ¼" steel angle, (see TR series drawings). Continuous bumper strips of 2" x 2" hardwood
      with neoprene pads bolted to the stop battens. Neoprene bumpers shall be flat head
      screwed with ferrules to hardwood at 4” o.c. Stop battens bolted to each tee with one
      3/8” diameter bolt.
   5. All mounting holes in tee bars, "U" plates and wall knees to be slotted to facilitate proper
      alignment vertically and horizontally. Lock washers at all joints.
B. Arbors

1. Size and weight capacity per schedule on Drawings.
2. Arbor top and bottom to be either steel plate formed channel with forged eyes for each lift line and for hand lines, approved steel forgings with integral eyelets, or approved welded assembly. Bottom plates threaded for connecting tension rods.
3. Arbor top and bottom joined on tee bar side by not less than 3" x ½" cold rolled steel (CRS) vertical flat bar fastened top and bottom by 2 3/8" bolts and tack welded.
4. Provide tee bar guide shoes mounted top and bottom of tie bar. Each to be 2 pieces of 5/16" UHMW separated by 5/16" UHMW spacer (or as required to properly fit the existing tee bar). Full width 3/16" steel reinforcing plate on front and back. Arbors over 15'-0" in length shall have an intermediate guide shoe attached to the steel back bar. Delrin shoes required for aluminum tees.
5. Provide two 3/4" high tensile strength threaded connecting rods between top and bottom spaced to fit counterweight slots. Fastened with 2 nuts and 1 lock washer each side of top and bottom.
6. Provide 12 gauge, 2" x 12" spreader plates to slip on connecting rods. Top spreader plate with spring keeper on front rod and locking stop collar on back rod. Provide 1 spreader plate for each 3'-0" of arbor height plus top spreader.
7. Provide forged eye as shown on the Drawings for utilization of capstan winch.
8. Provide metal angle iron "counterweight spacers" on any arbor where, after the pipe weight is installed, the counterweight is not level with the loading gallery. In all cases, on each arbor, the pipe weight must be level with the loading gallery.

C. Counterweights

1. Provide standard "U" slotted smooth flame-cut steel weights. All counterweight to fit all arbors (as set to set clearances allow) unless otherwise noted. Weights to be ground free of burrs or any sharp edges or protrusions. Weight to have diagonal cut at opposite corners. Provide the following sized weights:
   a. 6" wide counterweight:
      1) 11 pound weights 1/2" thick by 6" wide by nominally 14" long
         a) Provide 5%
      2) 22 pound weights 1" thick by 6" wide by nominally 14" long
         a) Provide 95%
   b. Pipe weight for general purpose linesets
   c. Main Drape and Valance
   d. 60% of total system working load limit capacity
      1) Approximately 52,000 lbs.
   e. All weights to be painted with shop coat of flat grey alkyd primer, Benjamin Moore Corotech Alkyd Shop Coat Primer or equal.
   f. All pipe weight to be completely painted bright yellow.
   g. After painting the counterweight shall be distributed:
      a. 90% at the loading gallery
      b. 10% at the stage floor
   h. Provide necessary thinner sheet steel weights for fine trimming of Main Drape.
   i. Batten balance and other permanent weights for all linesets to be permanently held in arbor by 2 bands standard mechanically locked steel strapping. Paint strapped weights bright yellow for identification.

D. Lift Lines:

1. Oil-free, zinc coated, 1/4", 7x19 aircraft cable. 7,000 lbs. minimum breaking strength for general linesets.
2. Pipe batten connection by:
   a. Pipe clamp
b. Rated hot dip galvanized jaw/jaw (cotter pin type) turnbuckle with 6" of take-up, lock nuts, lock washers and safety wire mouse (after adjustment).

c. Wire rope thimble

d. Copper compression sleeve installed as per manufacturer’s recommendation.

e. Dress cable ends using black heat shrink tubing.

3. Arbor connections by:

a. Thimble

b. Rated galvanized shackle, cotter pin type with cotters on inward side.

c. Copper compression sleeve installed as per manufacturer’s recommendation.

d. Dress cable ends using black heat shrink tubing.

e. Adjust lengths of lift lines to trim batten parallel to stage floor at low trim height as indicated on the Drawings.

E. Pipe Battens

1. Provide pipe battens complete with sleeves, connectors and fittings as indicated on the Drawings. Pipe to be of 1½" nominal Schedule 40 black iron pipe as per standard industry practice.

2. Batten joints to be secured with 18" close fitted internal sleeve by (2) 3/8” dia. bolts with lock nuts perpendicular to floor on each side of joint.

3. Batten ends to be covered with yellow vinyl caps to protect individuals from contact with cut pipe ends.

4. Battens to be painted with flat black enamel.

5. Battens to be marked with a 1" wide white stripe on centerline only, full circumference around pipe. Battens to be marked with 1'-0" measured increments from end to end. All markings to be in yellow enamel paint.

F. Operating (Hand) Lines


2. Dead tie with bowline at top, use 2 tight fitting half hitches after passing through eye at bottom of arbor, tape ends, or dress top with 2 removable nylon tie wraps.

3. Adjust length for proper tension block takeup after initial line stretch. Bottom of floor block to be approximately 9" above counterweight pit slab at time at final checkout.

G. Counterweight Locking Rails

1. Continuous 4" x 6" x ¼" steel tube locking rail, running the full length of the tee bar system. Drill for rope locks on required centers to match all tee bar spacing. Drill tube at 4'-0" centers to accept standard belaying pins. Provide 3" square steel engaging tube for capstan winch.

2. Provide (1) complete locking rail at the stage floor level. Refer to Drawings.

3. Rail stanchions of 3" square tube, not more than 5'-0" on center. Anchor to stage floor to withstand upward force of 350 lbs. per foot on rail.

4. Continuous white acrylic index strip as indicated on the Drawings.

5. Provide neoprene handle bumper on rail or integrated with rope lock (see below).

6. Provide lineset labeling on the onstage face of the locking rail.

H. Rope Locks


2. Cast iron bodies acceptable (#30 gray iron).


4. Slip ring to hold lever in locked position.

5. Provide 3/8" bolts to locking rail positioning lock on axis of arbor.

6. Operating handle and slip ring to be plastic covered.
7. All internal parts to operate silently. Provide internal neoprene pads and nylon cam shims.
8. Provide one rope lock per lineset as indicated in the Drawings for each tee bar space.
9. Provide one high quality, all keyed alike, padlock per each rope lock.

I. Tension Blocks
1. Provide 10" diameter cast #30 gray iron sheave, turned and grooved for 3/4" hand line, press-fitted with precision ball bearings.
2. Provide 5/8" minimum steel shafts held by self-locking hex nuts.
3. Steel housing or cast iron weighing, with sheave, not less than 30 pounds to maintain hand line tension.
4. Two UHMW and neoprene guide assemblies with ¼" steel full width backing plates on both sides of shoes, as for arbors, for free riding attachment to tee bar tracks.

J. Head Blocks
1. Heavy-duty machined cast ductile iron or #30 gray iron sheave turned and grooved for ¼" steel cable lift lines and for 3/4" operating line. Pitch diameter to be matched for steel cable and rope. Grooves to have 1/64" tolerance.
2. See schedule on Drawings for the number of grooves in each head block.
3. Sheaves to have 4" machine faced hubs bored for 2 press-fitted Timken 7204-B cup and 07100 preloaded cone roller, or equal. Alternates require specific approval.
4. Shafts of 1" diameter steel, locked to side plate, with adjustment nut factory tightened to manufacturer's torque specifications and locked to shaft by cotter pin or self-locking nut.
5. Sides not less than 3/16" CRS plate, welded and riveted to 1½" x 2" x ¼" steel base angles with 1½" legs horizontal, turned in and cut to clear vertical lines on 6-line+ sets. Base angle legs shall be turned out for 4-line sets. Side plates to span past edges of head block beam flanges by at least 1½". Side plates to span base angle cut and head block beam flanges by at least 1½".
6. Sides joined into rigid assembly by at least five 3/8" bolts with spacer pipes located where appropriate to retain cables in sheave grooves.
7. Head block sheave to be 12" in diameter, typical, unless otherwise noted on the Drawings.
8. Head blocks attached to the head block beam by double steel clips with forged offset or space plate for thickness of beam flange. Clips bolted to block by minimum (2) ½" dia. grade 5 bolts with nuts and lockwashers.

K. Loft Blocks:
1. Machined, cast ductile iron or #30 gray iron sheaves, 8" diameter, turned and grooved for one ¼" steel cable. 1/64" groove tolerance.
2. Shafts bored and press-fitted with double sealed precision ball bearing assemblies. SKF 60 Series 2 RS or equal.
3. Shafts of 5/8" diameter steel locked to side plate, with adjustment nut factory set for proper shaft and bearing adjustment and locked in place.
4. Side plates not less than 10 gauge CRS plate.
5. Base angles shall be 1½" x 1½" x ¼", with legs turned out.
6. Sides joined by five 5/16" bolts with pipe spacers same as head blocks located where appropriate to retain cables in sheave grooves and fully enclose sheave.
7. Idler sheaves (4" minimum diameter) may be of high strength nylon grooved for ¼" steel cable. Precision ball bearings. Provide spacers as required to locate sheaves ½" on center, sheave to sheave. Each loft block shall have one idler for each cable which passes it. Use of sag bars are not permitted.
8. Short line loft blocks to be multigroove sheaves with 1 groove for each pickup cable in set. Construction shall be similar to that indicated for the head block above, without the groove for the operating line.
9. Loft blocks attached to the beam by double steel clips with forged offset or space plate for thickness of beam flange. Clips bolted to block by minimum (2) 3/8” dia. grade 5 bolts with nuts and lockwashers.

L. Index Strip Light
1. Provide LED index strip light with 2 alternating circuits (white and blue). Fixtures will be dimmable LED, alternating white frosted and blue frosted. Index strip to be full length of locking rail. Suspend from outrigger batten as indicated in the Drawings. Mount the strip lights prior to connection by Division 26.
2. Provide local dimmers of appropriate voltage and capacity for each of the two circuits. Installation by Division 26.

M. Outrigger Battens:
1. Provide bracket support for index strip lights at the locking rail as indicated above and as shown on Drawings.
2. Outrigger batten and index strip light support brackets may not be fastened to the tee bar guide tracks.

N. Counterweight System Labeling
1. The linesets shall be labeled with the designations indicated on the Drawings in the following locations:
   a. The onstage face of the locking rail.
   b. The onstage flange of the counterweight head block well buck beam.
   c. The upper offstage railing of the loading gallery.
   d. Pipe ends
2. Labels shall be painted with enamel paint on structure using stencils or by a professional sign painter.

O. System Signage:
1. Provide signage indicating system load data for each of the following locations:
   a. Stage Level
   b. Technical Gallery
   c. Loading Gallery
2. System data shall include:
   a. “When Working on Galleries: Fall Protection Required When Loading/Unloading Counterweights from Arbors”
   b. Working Load Limit and total load capacity of general purpose sets
   c. Weight per each size of counterweight
3. Signage shall be made of 1/8” aluminum, painted finish.
   a. Block lettering of 1/4” high minimum letters.

2.5 PROSCENIUM SAFETY CURTAIN

A. General:
1. Proscenium Safety Curtain shall comply with the following:
   a. International Building Code Section 410.3.5 “Proscenium Curtain”
   c. NFPA 80, Chapter 20, “Fabric Fire Safety Curtains”
   d. Additional requirements of this specification where those requirements exceed the Code.
2. The safety curtain shall be a single non-asbestos fabric panel, motor operated, with fusible link and break-glass release emergency operation.
3. The curtain shall be made of noncombustible materials constructed and mounted so as to intercept hot gases, flames and smoke and to prevent glow from a severe fire on the stage showing on the auditorium side within a period of 20 minutes.

4. The curtain shall be so constructed as to withstand horizontal movement or bowing of no more than 2’ when subjected to lateral load of 2 lbs. per square foot over the entire area of the curtain.

5. The closing of the curtain shall have an average closing speed of not less then 6” / sec and not more then 24” / sec. The last 8’-0” of travel shall require not less than 5 second.

B. Safety Curtain

1. The safety curtain shall be fabricated from a non-asbestos coated curtain fabric made of 100% glass yarns. The weight of the material shall be approximately 40 oz. per square yard and approximately .08” thick. The material shall withstand continuous high temperatures to 1500 degrees Fahrenheit. The strength of the finished cloth in tension shall not be less than 260 lbs per inch warp width and 290 lbs per inch of filling width. The material shall not be affected by bleaches or mildew. The material shall be “Zetex Plus A-1210” as manufactured by Newtex Industries or equal.

2. All strips of fabric to be run vertically for the full height of the curtain; horizontal seams not permitted. Lap seams not less than 1” and sewn with 2 lines of stitching. The fire characteristics of the thread must not compromise the assembly.

3. Fabric at the sides to be turned back and sewn with a 6” flat hem reinforced with 16 gauge painted steel sheet metal on each side of hem.

4. Steel strap curtain guides, with ball bearing trolleys bolted in 3 places each to the side of the curtain, 1’-6” on center.

5. The top and bottom of the curtain shall have a 6-inch flat single-thickness pocket to hold the pipe batten.

6. Yield pad as shown on Drawings. Yield pad of noncombustible material not less than 3” thick to form a seal against the floor.

7. Finished curtain to overlap proscenium rated opening per code at top and sides. Curtain must extend into smoke pockets per code.

C. Pipe Battens

1. Provide pipe battens complete with sleeves, connectors and fittings as indicated on the Drawings. Pipe to be of 2” nominal Schedule 40 black iron pipe as per standard industry practice.

2. Batten joints to be secured with 18” close fitted internal sleeve by (2) 3/8” dia. bolts with lock nuts perpendicular to floor on each side of joint.

3. Battens to be painted with flat black enamel.

D. Smoke Stop and Smoke Pockets

1. The top of the curtain shall have a smoke stop fitted to make it as smoke tight as practicable.

2. The smoke pockets at the sides of the curtain shall be of structural steel shapes and plates not less than ¼” thick. Construction to be bolted, no welding permitted.

3. The smoke pockets shall be not less than 11” deep and 6” wide. The smoke pockets shall be set back from the face of the proscenium arch by at least 6”. The smoke pockets shall extend from the stage floor level to a point 3’-0” above the top of the raised curtain and shall be securely bolted to the proscenium wall. Coordinate attachment backing.

4. Details of construction and anchorage to be approved by local building and fire authorities and the Architect prior to fabrication.

E. Curtain Guide Track

1. Provide curtain guide channel track as shown on the Drawings.

2. Track to be not less than 14 gauge steel track with adjustable mountings for attachment to the smoke pocket assemblies.
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F. Lift Lines
   1. Oil-free, zinc coated, 1/4", 7x19 aircraft cable. 7,000 lbs. minimum breaking strength.
   2. Pipe batten connection by:
      a. Pipe clamp
      b. Rated hot dip galvanized jaw/jaw (cotter pin type) turnbuckle with 6" of take-up, lock
         nuts, lock washers and safety wire mouse (after adjustment).
      c. Wire rope thimble
      d. Compression sleeve installed as per manufacturer's recommendation.

G. Hoist Components
   1. Hoist motor shall be properly sized to carry the weight of the safety curtain. The motor
      shall have a minimum NEMA service factor of 1.25 for continuous operation. The motor
      shall be totally enclosed and fan cooled. Motor shall be C flange type mount. It shall
      operate on 3 phase, 208 VAC (confirm voltage with electrical contractor). Brakes shall
      be an integral part of the motor. Brakes shall be normally closed, direct acting, spring
      loaded, electrically released, and equipped with a manual release as well. Brakes must
      stop and hold 200% of the full load torque.
   2. Release of the safety curtain by any of the emergency release devices shall cause a
      hydraulic governor to control the decent of the safety curtain as outlined in 2.5.A.5 above.
      The hydraulic governor can be used as the primary brake but at no time shall the brake
      require electricity to hold the curtain in the up position or shall electricity be required to
      allow the safety curtain to be released and complete its travel. The hydraulic governor
      shall be an integrated unit - no hoses shall be required.
   3. Hoist gearboxes shall have combination helical-worm reducers, directly mounted by a
      flange to the motor. Gear reducers shall be selected to safely transmit the required
      power, torque and impact. All gear reducers shall have a minimum service factor of 1.50
      and an AGMA load classification of 1. The gear reducer case shall be high-tensile nickel
      cast iron. The helical gear shall be centrifugally cast bronze, mounted on a cast iron
      hub. The input and output shafts shall each be supported by two tapered roller bearings.
      The gears shall run in an oil bath. The shaft bearings shall be provided with double-lip
      oil seals to prevent leakage. There shall be a drip pan provided under the gearbox.

H. Limit Switches
   1. The primary limit control shall be a rotary limit switch connected to output shaft of
      gearbox. The limit switch shall be driven from the drive train by means of a roller chain
      or toothed belt transmission. All shaft connections shall be pinned or keyed.
      Connections using set screws shall not be acceptable.

I. Electronic Controls
   1. The electronic controls, mounted in the Production Control Panel as shown in the
      drawings, shall allow the curtain to go up, down or stop anywhere in its travel. This
      movement is independent of an “emergency release” situation. At no time shall the
      electronic controls inhibit the movement of the safety curtain during an “emergency
      release” situation.
   2. It shall be possible to reposition the safety curtain at any location in its travel using the
      constant contact (hold-to-run) UP and DOWN buttons located on the panel.
   3. The EMERGENCY STOP button, mounted on the same panel as the UP and DOWN,
      buttons, shall be the large “mushroom” type and shall be a true power interrupting
      disconnect.
   4. When using the electronic controls to operate the safety curtain, the time to fully open
      the curtain shall not exceed 60 seconds.

J. Motor Control Cabinet
   1. Provide wall mounted NEMA enclosure mounted at the gridiron level as shown on the
      drawings.
2. Panel shall utilize forward/reversing motor starter technology.
   a. Starters shall be specifically manufactured as a reversing starter with overload protection and mechanically interlocked to prevent simultaneous forward and reverse activation.
   b. Provide panels with current and thermal overload protection.
3. Provide Emergency Stop “mushroom” button mounted on the face of the enclosure.
4. Provide momentary key switches for local UP and DOWN control of the hoist on the face of the enclosure.
5. The enclosure must fit into the space provided. Field verify all site conditions

K. Cable Drums
1. Cable drums shall be designed to properly support the required loads without crushing or deformation. Drums shall have integral hubs, which will accept properly sized drum shafts for the transmission of loads and torque from the drive mechanism to the cable drums. Outboard ends of shafts shall be supported by self-aligning pillow block bearings. Drum shafts shall be continuous passing through both hubs and both bearing mounts. The drum hub shall be keyed to the drum shaft with keys, which are properly sized for the shaft diameter, and set-screwed through the hub. The length of the hubs and keys shall be sized for the torsional load on the drum.
2. Drums shall be grooved for the wire rope to be spiral wound. The pitch diameter of the drum groove shall be in accordance with recommendations of the wire rope manufacturer. The groove shall be machined to accept a minimum of 3/8 the rope depth, with 15 degree sloping sides, and spaced for a minimum clearance of 1/32” between cables.
3. There shall be a minimum of three dead wraps. Drums shall carry only a single layer of cable. An angled hole shall be drilled from the root of the cable groove through the drum wall for each cable. The axis of the hole shall be a 45-degree angle to a radial line through the center of the hole. The hole shall be chamfered, free of burrs and of correct size to retain a Nicopress cable retainer as manufactured by the National Telephone Supply Company or other approved connection.
4. All drums shall be machined to at least 63 RMS finish with concentricity to a rotational angle + 1/16”.
5. All stepped-down shaft corners and shoulders shall have proper fleet radius.

L. Cross Groove Detection:
1. Each cable drum shall be provided with a ground bar or limit switch which initiate an E-stop if any of the lift lines leave their established rope drum groove either due to slack line or cross groove condition.

M. Emergency Release Line (safety line)
1. Provide wire rope safety line with 165°F fusible links. Fusible links to conform to local and state codes.
2. Provide diverter sheaves where safety line changes directions as indicated on the drawings.
3. Provide diverter sheaves with bolted steel side plates and safety line keepers. Keepers must prevent a slack release line from coming out of the sheave groove.
4. Provide secondary mounting steel and hardware for attaching sheaves to structure.
   a. Safety line shall extend across the top of the stage within 12” of the roof support structure.

N. Electro-Mechanical Release Station
1. Provide an electro-mechanical safety line release activated by rate of rise heat detectors and by release of tension in the safety line.
2. Provide switch mounted in the release mechanism enclosure for testing system operation. Activation of release mechanism shall release tension in the safety line and close the safety curtain.

3. The release unit shall incorporate three pulleys to permit its attachment to the safety line at any point and to help prevent accidental release.

4. The release shall contain an integral battery and charger to provide emergency power during power interruptions. The release shall operate from a 120 VAC power source.

5. The electrical safety line release shall be UL Listed.

O. Emergency Release Station

1. Sheet metal enclosure, finished with red enamel paint. Stencil legend “IN CASE OF FIRE BREAK GLASS PULL RED PIN TO LOWER SAFETY CURTAIN” with white paint as indicated on the Drawings.

2. Mounting hardware as is appropriate for secure attachment of release station to proscenium wall. Metal enclosure shall be removable from the proscenium wall without releasing the safety curtain release line.

3. Emergency release line securely attached to steel release plate. Form line over thimble and secure line appropriately.

4. Provide 1/8” thick tempered glass window to cover steel release pull pin. Provide a steel mallet chained to the side of the pull pin box to break glass. Glass to be held in place with screws and clips for ease of replacement. Provide 2 spare panes of glass for replacement.

P. Safety Chains

1. Provide 3/8” welded proof coil chain rated not less than 3,700 lbs proof test or 1,800 pounds safe working load.

2. Anchor to gridiron channels with 3/8” forged eye bolt and shackle.

3. Attach to safety curtain top batten with ring batten clamp and shackle.

4. Adjust length to hold curtain upright at low trim.

Q. Safety Curtain Signage

1. On each side of proscenium, adjacent to the safety line, mount a sign panel not less than 9” high by 12” wide reading “IN CASE OF FIRE BREAK GLASS PULL RED PIN TO RELEASE SAFETY CURTAIN”.

R. Approvals Required

1. Provide the Architect with detailed plans and shop drawings for submission to local and State Fire Marshall. Shop drawings will not be released for fabrication until so approved.

2. Completed installation must be operated twice, and adjusted as necessary, for approval of the Architect, Theatre Consultant and local authorities.

2.6 STAGE TRAVELER TRACK ASSEMBLIES

A. Provide tracks for the traveler curtains and side masking draperies as indicated on Drawings and schedules. Complete with all necessary accessories (CWANA).

B. Track:

1. Track to be heavy-duty channel type, approximately 3” x 3”, 14 gauge steel or extruded aluminum formed to provide parallel double tracks for carrier wheels and totally enclosed except for bottom carrier slot.

2. Traveler tracks for bi-part drapes to be in two sections, with 2’-0” combined center overlap, fitted for manual line operation.

3. Each traveler track section to be a single piece, free of burrs, dents or irregularities. Sections for bi-part track assemblies clamped together by at least 3 lap clamps.
4. Hanger fittings and clamps for attachment spaced at 4'-0" on center maximum.

C. Carriers:
1. Provide one master carrier for each single-section line-operated traveler track.
2. Provide two master carriers for each double-section traveler track.
3. Master carriers to each have 4 paired neoprene wheels with ball bearings.
4. Master carriers to have 2 clamps for attachment of operating line and 2 plated swivels with 6" of usable trim chains for curtain attachment.
5. Single carriers to have 2 neoprene wheels with ball bearing with "hollow center" design to bypass the operating line.
6. Each single carrier to have single plated swivels with 6" of usable trim chain.
7. One single carrier for each 1'-0" of track length.
8. Provide end stacking (rear fold, back pack) devices to stack drapery only at offstage track ends. Provide rubber washers to packing tabs.

D. Traveler Track Pulley Blocks:
1. End pulley blocks heavy-duty type with 8" sheaves turned and grooved for 1/2" operating line. Double vertical sheaves on the live end of the tracks; a single horizontal sheave on the dead end. Housings firmly bolted to the track.
   a. Flying Traveler Tracks: Provide a single 45 degree slanted sheave on the dead end.
2. Floor pulley blocks to have 8" sheaves with sealed ball bearings. Sheaves mounted to slide vertically and clamp in a steel frame with full side plates of sufficient height to permit 9" tension and adjustment of operating line. Base drilled for 2 improved stage screws for floor mounting. Supply 2 improved stage screws and plugs.
3. All blocks to provide for positive retention of operating cords in grooves of sheaves.

E. Traveler Operating Hand Lines:
1. Each hand line to be a single length, first quality, 1/2" diameter, fiberglass center, braided cotton cord.
2. Rig for curtain operation from the live end of the track.
3. Length of hand line to be adjusted for tension with traveler curtains mounted and trimmed.

F. Products:
1. ADC #283-R
2. H&H #400
3. Or equal

2.7 PORTABLE CAPSTAN WINCH

A. Provide one side block capstan motorized bull winch.

B. Winch to have "gate block" for rope line.

C. Gear motor to be worm drive 180:1 reduction with 1750 RPM, 1½ HP, 208 VAC motor.

D. Gearmotor and idler block mounted in castered frame for portable use. Fabricate from steel tube with tab angle to secure to counterweight locking rail. Mount motor controls, pushbuttons, and snatch cleat to frame.

E. Provide with 50'-0" extension cord with twistlock male connector. Provide female receptacle with faceplate for installation under Division 26 Electrical work.
F. Provide 150'-0", 5/8" diameter, 14,500 lbs. minimum breaking strength, uni-directional, 100% polyester rope for use with the capstan winch with forged hook to attach to forged eye at bottom of arbor.

1. Provide "Sta-Set X" as manufactured by New England Rope or equal.

2.8 MOTORIZED ZERO-FLEET HOIST BATTENS – VALADE CENTER

A. Winch Architecture

1. Zero Fleet:
   a. Provide a system of compact vertically mounted “zero fleet” fixed speed winches to be located and mounted as shown on the drawings. Zero fleet is defined as the angle at which the wire rope leaves a grooved winch drum perpendicular to the groove; this angle must remain 0 degrees at all times.
   b. Winch system shall utilize motor drives local to each individual winch. Winch cables shall be connectorized for connection to wireways.
   c. The winches shall be mounted on a chassis bolted to structure as shown on the drawings.
      1) All mounting hardware is under this contract.
   d. Total width of winches shall not exceed dimensions as shown in the drawings.
   e. The motor carriage with drum or assembly of diverter sheaves shall move horizontally as the drum rotates to allow the pick-up lines to pass internal diverter sheaves maintaining a zero fleet angle.
   f. If required due to the hoist orientation, diverter sheaves allow the cable to exit the drum and immediately turn 90 degrees to exit the end of the winch parallel to drum axis.

2. Hoisting Capacity
   a. The safe working load (SWL) of the hoist shall be as listed in the Lineset Schedule.
   b. During the commissioning and Compliance Testing phase, this hoist shall be capable of lifting 25% more than the SWL without substitution of any components. See “System Start up, Owners Instruction and Commissioning” above.

3. Speed
   a. The speed of the hoist shall be as listed in the Lineset Schedule.

4. Lift lines:
   a. The number of wire ropes that will be attached to the hoist drum shall be as listed in the Lineset Schedule. The drum must be sized to accommodate the full travel, plus three dead (safety) wraps and space for two unused wraps for each lift line. The termination of each wire rope shall be by compression stop sleeve installed as per manufacturer’s recommendation to hold the wire rope firmly to the drum.
      b. Note: the total length of each lift line is a function of the travel distance and the distance from the hoist to the attachment point for the batten.

5. Travel Distance:
   a. The travel distance shall be as listed herein or as detailed in the drawings.

6. Limits:
   a. The hoist shall be capable of being stopped at any point between its initial up and initial down limits. The exact stopping point shall be determined by the information provided by an absolute encoder which is part of the hoist design.
   b. The hoist shall have the following hard struck limit switches:
      1) “Ultimate up” hard struck limit
      2) “Initial up” hard struck limit
      3) “Initial down” hard struck limit
      4) “Ultimate down” hard struck limit
   c. The initial hard limits, both up and down, stop the hoist from traveling but allow the operator to drive off the initial limit. The ultimate hard limits, both up and down,
initiate an E-stop in which power is removed from the motor drive after a fast deceleration.

d. In all cases, proper over travel must be provided in the hoist design to accommodate a failure of the control system. The hoist must come to a complete stop after striking an “initial up” or “initial down” limit without striking an “ultimate” limit. If the “initial limits” fail to function, the striking of an “ultimate” limit must bring the hoist to a complete stop before striking an immovable object.

7. Telemetry:
   a. The telemetry, i.e. position, of the moving element connected to the hoist shall be determined by the feedback of, at minimum, a single absolute encoder. This encoder shall be capable of accurately positioning the moving element. This encoder shall be mounted to the electric motor and shall not be belt driven.

8. Brake:
   a. Each hoist shall have a primary motor brake and a secondary brake. Each brake shall be cable of stopping and holding 200% of the hoisting capacity. Each brake shall be spring applied, fail safe, electromagnetically released.
   1) Secondary brake shall be on load side of hoist drive-train. Secondary brake shall be mechanically coupled to wire rope drum with as few connections as possible. Secondary brake located at the motor’s high RPM/low torque output shaft shall not be accepted

9. Load Detection:
   a. The hoist shall be provided with a load cell device which is capable of determining the load which has been added or removed from the system. This device shall be integrated into the control system and each hoist shall be able to “learn” its load, as a safeguard against unintentionally overloading or under-loading the hoist.
   b. The control system must initiate a stop if the system load changes by more than ±6%. This threshold shall be user adjustable.
   c. In no case shall the software system allow movement if the SWL is exceeded.

10. Cross Groove Detection:
    a. The hoist shall be provided with a ground bar or limit switches, one per each lift line, which initiate an E-stop if any of the lift lines leave their established rope drum groove either due to slack line or cross groove condition.

11. Drum rollers:
    a. Provide pinch rollers to ensure lift lines are held in their groove at the tangential point at which the lift line exits the drum.
    b. Rollers shall rotate on sealed ball bearings. Plain bushings shall not be accepted.
    c. Rollers shall be machined to match the profile of the lift lines. Machined rollers shall include at least one profile to ride in an empty drum groove and at least one groove for exiting lift line.

12. Power and Control Distribution
    a. Each hoist shall be connected to electrical power via an 8’-0” long cable extending from the rear of the hoist to the source outlet in the Power and Control Distribution box. (coordinate with Electrical Contractor).
    b. The control circuit shall be attached to the hoist via a separate control wire that is also 8’-0” long and shall be connected at the hoist and at the Power and Control Distribution box.
    c. The receptacles shall be installed in a sheet metal junction box and shall include a power and control outlet.
    d. The distribution box shall include a 3 phase motor rated breaker sized for the operating horsepower of the motor.
    e. The wiring and connectors shall be barriered between high and low voltage.
    f. The Power and Control Distribution box shall be UL listed.
    g. Control wiring terminations shall be made via an IDC style connector.
    h. Hoists shall connect to the control panel via a single CAT-5e style cable.
i. The Control Panel shall operate on low voltage power supplied via the control cable that connects the control circuit to the power and control distribution box.

j. A centralized contactor cabinet with individual multiple wire connecting to each hoist shall not be acceptable for this installation

13. The hoist shall be:
   a. Prodigy EXO P900G Hoist by ETC Rigging
   b. or approval equal

B. Lift Lines:
   1. Oil-free, zinc coated, 3/16” 7x19 aircraft cable. 4,200 lbs minimum breaking strength.
   2. Pipe batten connection by:
      a. Pipe clamp
      b. Rated hot dip galvanized jaw/jaw (cotter pin type) turnbuckle with 6” of take-up, lock nuts, lock washers and safety wire mouse (after adjustment).
      c. Wire rope thimble
      d. Compression sleeve installed as per manufacturer’s recommendation.
      e. Dress cable ends by black heat shrink tubing.
   3. Adjust lengths of lift lines to trim batten parallel to stage floor at low trim height as indicated on the Drawings.

C. Pipe Battens
   1. Provide segmented battens complete with sleeves, connectors and fittings as indicated on the Drawings. Pipe to be of 1½” nominal Schedule 40 black steel pipe as per standard industry practice.
   2. Batten joints to be secured with 18” close fitted internal sleeve by (2) 3/8” dia. bolts with lock nuts perpendicular to floor on each side of joint.
   3. Batten ends to be covered with yellow vinyl caps to protect individuals from contact with cut pipe ends.
   4. Battens to be painted with flat black enamel.
   5. Battens to be marked with a 1” wide white stripe on centerline only, full circumference around pipe. Battens to be marked with 1’-0” measured increments from end to end. All markings to be in yellow enamel paint.

D. Loft Blocks:
   1. Machined, cast ductile iron or #30 gray iron sheaves, turned and grooved for one 3/16” steel cable. 1/64” groove tolerance. Wire rope to sheave D to d to be 26 times minimum.
   2. Sheaves bored and press-fitted with double sealed precision ball bearing assemblies. SKF 6000 Series 2RS or equal.
   3. Shafts of 5/8” diameter steel locked to side plate, with adjustment nut factory set for proper shaft and bearing adjustment and locked in place.
   4. Side plates not less than 10 gauge CRS plate.
   5. Base angles shall be 1½” x 1½” x ¼”, with legs turned out.
   6. Sides joined by five 5/16” bolts with pipe spacers located where appropriate to retain cables in sheave grooves and fully enclose sheave.
   7. Custom UHMW idler block as shown on drawings.
   8. Loft blocks attached to the beam by double steel clips with forged offset or space plate for thickness of beam flange. Clips bolted to block by minimum (2) 3/8” dia. grade 5 bolts with nuts and lockwashers.

E. Mule Blocks
   1. Individual cast ductile or #30 gray iron sheaves, 8” in diameter, turned and grooved number of 3/16” steel cables muled. Bearings and tolerances as for loft blocks indicated above.
   2. See Drawings for number of grooves required per unit.
3. Shafts of 3/4" diameter steel locked to side plate, with adjustment nut factory set for proper shaft and bearing adjustment and locked in place.
4. Side plates to be 10 gauge CRS plate.
5. Mounting to be by steel clip and channels, minimum (4) ½” dia. grade 5 bolts and lockwashers, as required to assure positive alignment. Shims and spacers as required.
6. Provide as required for clearance of field conditions

F. Upright Idler
   1. Idler assembly machined in 2 halves to accommodate 3/16” wire rope as shown in drawings.
   2. Mounting to be by steel clip and channels, minimum (4) ½” dia. grade 5 bolts and lockwashers, as required to assure positive alignment. Shims and spacers as required.
   3. Provide as required for clearance of field conditions

2.9 RIGGING CONTROL SYSTEM (RCS) – VALADE CENTER

A. The control system shall be designed for the control of theatrical rigging, specifically the automated hoists, provided in this section.

B. The system shall be easy to understand and operate that result in accurate position of all motorized rigging in the system.
   1. Controller shall be wall mounted as shown on the drawings.

C. Controller shall display the position of batten’s bottom pipe in feet and inches above the finished stage floor.

D. System shall detect weight imbalance as little as 6% variance over or under predefined load shall cause the axis to stop. Only motion in the opposite direction shall be allowed to correct the fault.

E. Provide all necessary contactors, relays, protective devices, motor starters, motor drives etc. in NEMA enclosures for installation by Division 26.

F. Functions:
   1. Provide digital two-way communication between the controller and hoist units. This communication must include feedback loop information, E-Stop information, position information, error information as well as all other vital system statistics.
   2. System must continually monitor and control all safety functions including but not limit to, E-stop, slack line, over current, over temp, limits and over speed, etc.
   3. System shall be programed to run no more than 2 hoists simultaneously.

G. Display Functions:
   1. Provide LCD display with feedback and operating information.
   2. Display window shall include position, axis name and number, weight of load, preset position, and status indicators for e-stop and the nature of any faults.

H. System Computer:
   1. The computer architecture and all central processing for the control system shall be a specifically designed for controlling stage movement machinery. The computer shall utilize multi-processing architecture and interact with the remote control elements described herein.
   2. Provide necessary signal and information storage devices to provide back-up.
   3. Computer shall be configured to allow performance upgrades and “fixes” via software, without replacement of non-defective hardware.
4. Backup:
   a. All input and recorded data shall be stored in a timed backup on non-volatile flash memory.
   b. Provide USB port and flash drive or appropriate removable storage media, for archival recording of all functions.

5. The computer shall issue control commands to the hoist electronic motor drive modules via an industry standard control protocol i.e. Ethernet – Cat 5 UTP, SIMOLINK or Profinet by way of a cable plant established for this sole purpose.

6. Provide an uninterruptible power supply rated to power control equipment for 30 minutes

I. Event Log:
   1. All user functions including log-in and logout, failed attempts, user operations, keystrokes, system errors, axis faults, limit strikes, slack line faults, load sensing, hardware faults, over temperature and the like shall be recorded with time and date of action and operator identity.
   2. A separate event log shall be created for analysis and reporting purposes.
   3. Access to the event log shall be defined by the System Administrator.

J. Trims:
   1. Provide at least one preset trim (predetermined trim positions) per axis.
   2. The programmable trims shall be independent of programmed top and bottom limits stops.

K. Monitor of Limit Functions:
   1. There shall be hard struck ultimate over travel limits in both directions acting directly on motor drive and will stop the movement completely. Resetting these limits shall require investigation of the condition and physical bypass of the limits to reset the system. (See Fault Diagnosis below)
   2. There shall be hard struck initial over travel limits in both directions, these limits, when struck, will stop the movement completely, however the control system can be operated to “drive off” the limits to correct the fault. (See Fault Diagnosis below)
   3. In addition to the four hard struck limits, the control system shall have user assignable soft ultimate limits.

L. Fault Diagnosis:
   1. Immediately upon a fault on any axis the system shall display an error message on all active displays.
   2. The error message shall be specific with regard to the fault, such as overload, slack line, limits, E-stop, position error, etc.
   3. The exact axis, number, location, and type of fault shall be displayed. In addition, the check requirement, such as “reset”, check limits, etc., shall be indicated on the display.
   4. E-stop trip location shall be displayed in the event of a manual local trip. All faults shall be logged in the event log.

M. Emergency Stop:
   1. Provide low voltage logic signal called “E-STOP”. E-stop function shall enable redundant safety line contactor disconnecting power to motor drive. No motor element shall function unless “E-STOP” is deactivated. However, it is a priority that one single component failure shall not render entire system unusable.
   2. The E-stop and ultimate over travel limit switches shall be a part of a circuit which is separate from and redundant to the normal end of travel limit switches. This circuit shall not depend on the software or electronic logic. Operation of an E-stop or ultimate over travel limit switch directly disconnect power from the winch(es) using a UL580E type 2, non-welding positive break contactor. An override mechanism to allow resetting of the over travel limits shall be included.
3. E-Stop on individual decentralized motor drive cabinets shall initiate a global E-Stop.
4. Provide additional “E-STOP” stations as shown on drawings.

N. Acceptable Products:
   1. QuickTouch 4-channel and Remote Control by ETC Rigging

2.10 TENSION WIRE GRID

A. Design Criteria:
   1. The following design criteria are intended to establish minimum safety requirements. 
      Where Federal, State and Local legislation address these topics, the more stringent 
      requirement shall take precedence. Factors listed below in no way relieve the contractor 
      from the sole responsibility for furnishing a safe and properly engineered system.
   2. Cables, fittings, load bearing components: Minimum safety factor of 8x.
   3. Maximum woven cable surface deflection at mid-span: Not greater than L/80 under a 
      150# load on a 12” x 12” area.
   4. Maximum frame compression on any member: 5000#.
   5. Design live load on grid: 20# p.s.f. over a panel.

B. Tension Grid Frame Assembly
   1. Tension wire grid frames to be welded assemblies of structural steel, sized appropriately 
      for this application. Overall dimensions of the frames as per the Drawings and as verified 
      by field survey of structural support grid.
   2. Frame assembly to be drilled, de-burred and chamfered for attachment of woven wire 
      rope grid. Live end (swaged fitting) holes and dead end (compression sleeve) holes to 
      be 9/32” diameter.
   3. Frame assembly to be finished with flat black enamel.

C. Tension Grid Woven Wire Rope Grid
   1. The walking surface of the tension wire grid shall be made of 1/8” wire rope woven at 2” 
      on center in two directions. Connections to channel frame assembly by swaged fittings 
      and compression sleeves as per Drawings and indicated herein.
   2. Where members having sloping flange faces, bolted connections shall be provided with 
      appropriate beveled washers to afford square seating of heads and nuts. Alternate 
      method: weld pipe section in place to accommodate a bend in the wire rope.
   3. Wire rope lengths shall be continuous lines from the same spool, free of knots, splices 
      or mechanical fasteners along their length unless specifically required in the Contract 
      Documents.
   4. Wire rope shall be oil free, preformed 1/8” diameter 7x19 galvanized and blackened 
      cable. Blacken by means of electro-statically applied powder coat. Cable shall be rated 
      at not less than 2,000 pounds. Damaged or deformed cables shall not be used.
   5. Blackened wire rope shall be the product of:
      a. Fehr Brothers (no known equal).

D. Tension Grid Swaged Fittings
   1. Swaged fittings shall be Type 303 selenium bearing, corrosion resistant stainless steel. 
      Stud fittings shall be sized for 1/8” wire rope and be threaded as required to meet the 
      criteria established herein and on the Drawings.
   2. Swaged fitting shall be secured in place with 1 washer and 2 nuts.

E. Tension Grid Compression Sleeves
   1. Compression sleeves shall be sized appropriately for the cable construction and 
      diameter of the cable with which they are employed. Sleeves shall be cylindrical for stop
sleeves. Sleeves shall be copper. After application, sleeves shall meet or exceed the latest requirements of Military Specification MIL-W-83420.

F. Compression sleeves and tools shall be the product of:
   1. National Telephone Supply Company, Locoloc, or equal.

G. Temporary Compression Struts
   1. If required to prevent deformation during fabrication, provide temporary compression struts. Struts to remain in place until modules are welded down, and tension tabs and perimeter gussets are welded in place.
   2. Struts to be completely removed after welding is complete. No remnants or finish variations permitted.

H. Tension Tabs And Perimeter Gussets
   1. Tension tabs and perimeter gussets shall be installed in order to prevent the deformation of the module channel frame.
   2. After placement and weld-down of tension grid modules and prior to the removal of the temporary shipping struts, weld 1” x 6” steel strap between adjacent modules, top and bottom. Provide tension tabs at third points on all side. Alternate on either side of centerline across a row to permit future access to wire rope fittings. Center tabs between holes.
   3. For the perimeter conditions, after placement and weld-down of tension grid modules and prior to the removal of the temporary shipping struts, weld 4” leg 45 degree triangle steel gusset between module channel and understructure. Provide gussets at third points of module. Locate centered between holes.

I. Tension Grid Signage
   1. Signage shall be legible both in construction and grammar. A diagram depicting the system layout and maximum load limitations (drawn not less than 1/2” = 1'-0”) shall be wall-mounted in a protective transparent faced frame on the wall near the entrance to the grid as to be plainly visible, and as not to interfere with the operation of systems.
   2. Provide verbiage in English as listed below:

   **WARNINGS FOR TENSION GRID:**

   MAXIMUM LOAD - 4 PERSONS PER MODULE (20 lbs./sq.ft.)
   DO NOT BOUNCE ON SURFACE
   SECURE LOOSE ITEMS
   MAINTAIN CABLE WEAVE AT 2” SQ.

2.11 DRAPERY TRACK

A. Walk-Draw Track
   1. Furnish and install walk-draw traveler tracks for surround masking draperies as indicated on Drawings and schedules, complete with all necessary accessories (CWANA).
   2. Track:
      a. Track to be heavy-duty extruded aluminum type, approximately 3-1/4” high x 1-5/8” wide I-beam, 7 gauge. Extruded shape shall provide parallel tracks for carrier.
      b. Tracks to be single pieces, free of burrs, dents or irregularities.
      c. Provide straight track and radius track sections as per contract drawings.
      d. Splice sections as required for continuous installation as per contract drawings.
      e. Finish Black.
      f. Provide attachment to pipes and walls to properly support track along its entire path.
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THEATRICAL RIGGING

2.12 REMOVABLE DEAD HUNG DRAPERY BATTENS

A. Furnish and install dead hung pipe battens for support of masking drapery and tracks.

2.13 HAND WINCH HOUSELIGHT PIPES

A. Provide batten, connection, cable, loft blocks, head blocks, and (2) house light battens. The house light battens shall be driven by manually operated winches that are mounted house right. It shall be able to raise and lower the house light batten as indicated on the drawings.

B. Provide required steel to mount assemblies to the building structure.

C. Pipe battens
   1. Specifications as per Section 116133 – Theatrical Rigging, paragraph 2.4E – Pipe Battens.

D. Pipe batten connection by:
   1. Pipe clamp
   2. Rated hot dip galvanized jaw/jaw (cotter pin type) turnbuckle with 6" of take-up, lock nuts, lock washers and safety wire mouse (after adjustment).
   3. Wire rope thimble
   4. Compression sleeve installed as per manufacturer's recommendation.
   5. Dress cable ends by clear heat shrink tubing

E. Hand Pile Wind Winch
   1. The winch shall be a six lift line pile-on (yo-yo) type drum winch.
   2. Winch shall be a hand cranked, oil bath, geared reduction unit with a 1200-pound lifting capacity. The winch shall be fully enclosed and supplied with a sturdy metal handle.
   3. The hand crank shall operate from front side of the winch and be removable for storage. The hand crank shall be located at the proper height for easy operation. The enclosure shall have signs warning that the handle must be removed when not in use.
   4. The cable drum shall be of welded steel construction and carry 24 feet of 3/16" diameter galvanized aircraft cable. Minimum 4 dead wraps.
   5. The winch shall be locked in position by a caliper disk brake capable of holding 200% of the rated load.
   6. Wall mount with support assembly.
7. Hand Winch system shall be:
   a. Thern: PW11-M Series
   b. Or approved equal

F. Lift Lines:
   1. Oil-free, zinc coated, 3/16", 7x19 aircraft cable. 4,200 lbs minimum breaking strength

G. Head Blocks:
   1. Machined, cast ductile iron, #30 gray iron, or high strength filled nylon sheaves, 8" diameter, turned and grooved for six 3/16" steel cables. 1/64" groove tolerance.
   2. Sheaves bored and press-fitted with double sealed precision ball bearing assemblies. SKF 60 Series 2 RS or equal.
   3. Shafts of 5/8" diameter steel locked to side plate, with adjustment nut factory set for proper shaft and bearing adjustment and locked in place.
   4. Side plates not less than 12 gauge CRS plate and bolted to base angles. Side plate shall fully enclose the sheave.
   5. Base angles shall be 1½" x 1½" x ¼", with legs turned out.
   6. Sides joined by five 5/16" bolts with pipe spacers located where appropriate to retain cables in sheave grooves and fully enclose sheave.
   7. Head blocks attached to the beam by double steel clips with forged offset or space plate for thickness of beam flange. Clips bolted to block by minimum (2) ½" dia. grade 5 bolts with nuts and lockwashers.

H. Loft Blocks:
   1. Machined, cast ductile iron, #30 gray iron, or high strength filled nylon sheaves, 8" diameter, turned and grooved for one 3/16" steel cable. 1/64" groove tolerance.
   2. Sheaves bored and press-fitted with double sealed precision ball bearing assemblies. SKF 60 Series 2 RS or equal.
   3. Shafts of 5/8" diameter steel locked to side plate, with adjustment nut factory set for proper shaft and bearing adjustment and locked in place.
   4. Side plates not less than 12 gauge CRS plate and bolted to base angles. Side plate shall fully enclose the sheave.
   5. Base angles shall be 1½" x 1½" x ¼", with legs turned out.
   6. Sides joined by five 5/16" bolts with pipe spacers located where appropriate to retain cables in sheave grooves and fully enclose sheave.
   7. Idler sheaves (4" minimum diameter) may be of high strength nylon grooved for 3/16" steel cable. Precision ball bearings. Each loft block shall have one idler for each cable which passes it. Use of sag bars are not permitted.
   8. Loft blocks attached to the beam by double steel clips with forged offset or space plate for thickness of beam flange. Clips bolted to block by minimum (2) 3/8" dia. grade 5 bolts with nuts and lockwashers.

2.14 CABLE REELS AND ASSOCIATED CABLE

A. Furnish cable reels for the architectural lighting pendant fixtures as indicated in the TR series drawings.

B. Furnish each reel with hybrid power/data cabling for the following:
   1. One 120vac 20amp switched circuit
   2. One DMX lighting control cable.
   3. All cables shall be heavy duty, flexible, and suited for installation into energy chain.
   4. All cable must be installed in each reel prior to delivery to site.
C. Reels shall be spring-driven. Size spring units for lift application with travel as indicated in the TR series drawings

D. Furnish Kellem's® mesh type cable grips and mounting hardware at connection to pendant fixture junction box per TR series drawings. Coordinate straight or 90 degree elbow type with architectural lighting manufacturer and Division 26.

E. Furnish reel terminal box with voltage separation for incoming power and data conductors

F. Provide all required components for reel mounting
   1. Provide strut and hardware as required.
   2. Provide bracing as required to stabilize reels while in operation.

G. Furnish:
   1. E-spool reel with 1 twistband by Igus
   2. or approved equal

2.15 MISCELLANEOUS RIGGING EQUIPMENT AND ACCESSORIES

A. Provide loose rigging equipment and accessories as indicated in the Appendix.

2.16 MAIN DRAPE AND VALANCE

A. The face material of the Main Drape and Valance shall meet or exceed the following criteria:
   1. 100% Inherently Flame Retardant (IFR) polyester velour
   2. Acceptable products:
      a. Rose Brand 25 oz. “Prestige”
      b. Dazian 25 oz. “Angelo”
      c. or approved equal
   3. The color shall be selected by the Architect from the manufacturer’s standard color choices.

B. Line with black IFR lining fabric. Tack lining to face material by sewing cording between each face material seam and the lining material at 4'-0” on center vertically. Tack lining to face material hems every 4'-0” on center horizontally in a similar fashion.
   1. Acceptable Products
      a. Rose Brand “Avora Lining”
      b. Rose Brand “Poly Chintz”
      c. Or equal IFR lining fabric

C. Main Drape Construction:
   1. Two panels for bi-part action, with continuous border as indicated on drawings. Each panel finished with 75% fullness, box pleated and sewn down.
   2. Sew with nylon thread. Color to match face material. Thread shall have no apparent sheen with relationship to the velour.
   3. All finish webbing to be black heavyweight polypropylene, unless otherwise indicated.
   4. The center edges of each panel faced back with a full width of fabric plus 1'-0” (minimum) and hand-tacked entire height with continuous catch stitching spaced 4” apart, seizing lining and facing material.
   5. Offstage edges faced back 1'-0”.
6. Provide pocket for storage of floor block at the offstage edge of the live end of the Main Drape.
7. Provide a paging handle for the upstage panel of each bi-parting curtain set. The paging handle shall be located on the back face of the onstage side of the panel with the point of attachment located 48" above the bottom of the curtain.
   a. Each handle to be fabricated of a 12" loop of velour face material which is sewn around a core of heavy-duty 2" black polypropylene webbing.
   b. Each handle to be stitched to the back of the center edge of the panel and seized in the stitching where the face material is turned back. Sewing for the attachment of the handle shall not be visible on the face of the curtain panel.
8. Box pleats at top of panels 1'-0" O.C. reinforced with heavyweight 3½" polypropylene webbing. Vertical seams to be located so as to be hidden behind pleats.
9. At center of each pleat on main drape, provide 1" cadmium plated rigid eye snap hook attached by nylon webbing strap sewn and riveted through curtain and polypropylene webbing with two rivets. This assembly shall be centered on the webbing. Provide double layer of polypropylene webbing (3½" square) at snap hook locations.
10. 6" double-turned bottom hems with 0.75 lb per foot weighted tape in a separate pocket inside hem. Continuous chain of equal weight, sewn in, acceptable. Weight pocket to be 1" short of finished hem for main drape, equal to finished hem for valance. Ends of weight pockets to be secured with 1½" wide black hook-and-loop fastener for the full height of the pocket opening.
   a. Weights shall be shipped separately from draperies and installed in weight pockets in the field.
   b. A pull-line or tape shall be placed within each weight pocket prior to shipping. The pull line shall be provided to facilitate installation of weights in the field.
11. Size and quantity as indicated in the Drapery Schedules.

D. Valance Construction:
1. Entire drapery shall be continuous, finished with 75% fullness, box pleated and sewn down.
2. Sew with nylon thread. Color to match face material. Thread shall have no apparent sheen with relationship to the velour.
3. All finish webbing to be black heavyweight polypropylene, unless otherwise indicated.
4. Offstage edges faced back 1'-0".
5. Box pleats at top of panels 1'-0" O.C. reinforced with heavy weight 3½" polypropylene webbing. Vertical seams to be located so as to be hidden behind pleats.
6. At center of each pleat on valance, provide #2 black oxide finish brass grommets, double grommets at both ends. Center grommets on webbing. Provide double layer of webbing (3½" square) at each grommet.
7. Mark with centerline designation on heavy-duty muslin with permanent markings, sewn securely to webbing. 2" high letters minimum.
8. Provide one 2'-0" black #4 cotton braided tie line at each grommet. Center tie line to be white. Finish ends of tie lines to prevent unraveling.
9. 6" double-turned bottom hems with 0.75 lb per foot weighted tape in a separate pocket inside hem. Continuous chain of equal weight, sewn in, acceptable. Weight pocket to be equal to finished hem for valance. Ends of weight pockets to be secured with 1½" wide black hook-and-loop fastener for the full height of the pocket opening.
   a. Weights shall be shipped separately from draperies and installed in weight pockets in the field.
   b. A pull-line or tape shall be placed within each weight pocket prior to shipping. The pull line shall be provided to facilitate installation of weights in the field.
10. Size and quantity as indicated in the Drapery Schedules.

2.17 ACOUSTIC DRAPERIES

A. The face material shall meet or exceed the following criteria:
1. 100% Inherently Flame Retardant (IFR) polyester velour

B. The color of all acoustic draperies shall be black.
C. Drapery operation as indicated in the schedules. Each panel finished with fullness as indicated in the schedules, box pleated and sewn down.
D. Sew with nylon thread or cotton thread. Color to match face material. Thread shall have no apparent sheen with relationship to the velour.
E. All finish webbing to be black heavyweight polypropylene, unless otherwise indicated.
F. Edges of masking panels are to be faced back with at least 3" hems. Hand-tack entire height with continuous catch stitching spaced 4" apart.
G. Tops reinforced with 3½” polypropylene webbing with #2 black oxide finish brass grommets, 12” O.C.; double grommets at both ends. Center grommets on webbing. Provide double layer of webbing (3½” square) at each grommet.
H. Bottoms to have 6” double-turned hems with #8 zinc coated chain in separate pocket inside hem. Weight pocket to be 1” short of finished hem. Ends of weight pockets to be secured with 1½” wide black hook-and-loop fastener for the full height of the pocket opening.

1. Weights shall be shipped separately from draperies and installed in weight pockets in the field.
2. A pull-line or tape shall be placed within each weight pocket prior to shipping. The pull line shall be provided to facilitate installation of weights in the field.

I. Provide all attachment hardware to mount drapery to curtain track carriers.
1. Sizes and quantities as indicated in the Drapery Schedules

2.18 SOURCE QUALITY CONTROL

A. All equipment and components to be factory tested prior to shipping.

2.19 FABRICATION

A. Fabricate all work in this section in accordance with the Architect’s direction, specifications, approved shop drawings, pertinent project drawings, established trade practices and applicable code requirements.

B. Machine-finish all operating parts to standard trade tolerance, fits and finishes.

C. Carry out shop welding in full accordance with the appropriate sections of the “Specification for the Design, Fabrication and Erection of Structural Steel for Buildings” of the American Institute of Steel Construction (AISC).

D. Draperies
1. Each drapery to have identification tag sewn to the webbing at the upper offstage corner of the goods. Identification tag should contain the following information:
   a. Manufacturer’s Name
   b. Date of manufacture
   c. Finished size of goods
   d. Recommended cleaning instructions
2. Fabric runs to be full height without joints or intermediate seams.
3. In no case shall a seam between fabric runs fall directly at the finished end of a piece of goods. Provide 1'-0" minimum from end of goods to a seam, either on the front or back face.
4. Nap of velour sewn down unless otherwise specified.

5. Ends of chain and pipe pockets to be closed with 1½” wide hook and loop fasteners minimum.

6. Hang-out and Straightening
   a. All draperies shall be pre-hung for stretch and final length and trim prior to delivery. This shall be done at the scenic studio or at the job site given clean conditions.

PART 3 - EXECUTION

3.1 INSTALLERS

A. The systems, equipment and services described herein shall be provided by a Theatrical Engineering and Rigging Contractor who will be responsible for all the work of this Section, including but not limited to coordination and supervision of the engineering, shop drawings, fabrication and provision for all systems specified herein and shown in the drawings.

B. To establish comparative standards of quality, the provision of the equipment and services of this section shall be by one of the following contractors:

   Beck Studios, Inc
   1001 Tech Drive
   Milford, OH 45150
   Tel: (513) 831-6650

   Gopher Stage Lighting
   4141 Cedar Avenue
   Minneapolis, MN 55407
   Tel: (612) 871-0138

   J.R. Clancy Incorporated
   7041 Interstate Island Road
   Syracuse, NY 13209-9713
   Tel: (800) 836-1885

   Stagecraft Industries
   5051 North Lagoon Avenue
   Portland, OR 97217
   Tel: (503) 286-1600

   Texas Scenic Co.
   8053 Potranco Road
   San Antonio, TX 78251
   Tel: (210) 684-0091

C. Substitution Limitations

   1. Any contractor who wishes to be listed and has not been pre-approved must submit qualification information to the Architect. Proposal shall include all of the information listed below:

      a. Statements of financial responsibility for the past five fiscal years showing assets and liabilities.
      b. List of principal officers and design and service engineers in an organizational structure flow chart.
c. List of not less than 5 projects of similar size and scope completed within the five years on which contractor has provided full services: product engineering, shop drawings, manufacture, installation and commissioning. In each instance, indicate specifics of scope of fabrication and installation. Include a contact list: name, address and phone numbers of person(s) directly responsible for operation and maintenance of equipment in each facility.

d. List of current projects and approximate contract value and completion dates. Include list of names, phone numbers and addresses of owner, owner's representatives and architect.

e. For each above described project, list of names of persons who supervised preparation of shop drawings, manufacture of components, and installation of equipment.

f. List of names of persons who would do project management, product engineering, supervision of shop drawing, and supervision of installation should this contract be awarded.

g. Contract Bond Company information indicating that contractor has bonding capacity for full duration of project. Include list of other bonded projects coinciding with this project.

h. Evidence of ability to undertake custom product engineering to meet specific requirements of project specifications. Provide sample project engineering drawings for custom products and contact information for facility operators where those products have been installed.

2. Standards of Acceptance:

a. Refer to Paragraph 1.8B - Quality Assurance/Qualifications.

3.2 EXAMINATION

A. Verification of Conditions: Contractor must examine areas and conditions under which the equipment is to be installed and must notify the General Contractor in writing of conditions detrimental to proper and timely completion of work. Work will not proceed until unsatisfactory conditions have been corrected in a manner acceptable to the Contractor.

3.3 INSTALLATION

A. Install all work in this section in accordance with the Architect's direction, specifications, approved shop drawings, pertinent project drawings, established trade practices and applicable code requirements.

B. Provide site supervision during the installation of electrical work associated with the Theatrical Rigging system elements.

C. Install all work securely, complete with all bolts, nuts, washers, clips, fittings, supports, and other items required for proper installation and operation.

D. Position all items accurately as indicated on drawings and true to plumb, line and level. Maintain maximum headroom and clearances at all points.

E. Coordinate work with all other trades to avoid causing delays in construction schedule.

F. All field welding requires prior approval of the Architect and Contractor's Structural Engineer.
G. Carry out approved field welding in full accordance with the appropriate sections of “Specification for the Design, Fabrication and Erection of Structural Steel Buildings” of the American Institute of Steel Construction (AISC).

H. Do all cutting, drilling, tapping and approved welding required to properly install work. Obtain Architect’s prior approval for cutting and drilling of existing structural work.

I. Clean structural steel and fabricated steelwork of rust, scale and foreign matter by grinding; prime with 1 coat of primer; finish with 1 coat of first quality machinery enamel free of skips, runs and saps. Touch up all field connections, welds and abraded places with primer and enamel.

3.4 FIELD QUALITY CONTROL

A. The installation of the equipment indicated in this Section shall be supervised by qualified personnel who are regularly employed by the Contractor for supervision of equipment installation similar to that indicated herein.

1. Installation supervisor shall be an ETCP Certified Rigger for Theater.

B. Installers must be appropriately skilled and experienced for the type and quality of work.

C. Arrange for all tests and inspections required by the General Requirements.

3.5 SYSTEM STARTUP AND COMMISSIONING

A. Commissioning

1. Upon completion of installation work required by the work of this Section, the Contractor shall perform all required tests and inspections, including but not limited to the Compliance Testing Procedures specified herein.

2. Contractor shall supply all equipment required for the commissioning process including access equipment (personnel lifts, ladders and appropriate protective equipment), test instruments and communications equipment.

3. Contractor shall provide staff to assist in the commissioning process.

4. Compliance Testing Procedures (CTP)

a. The Compliance Testing Procedures are designed to verify that all system motor drive elements function as specified. The following represents a sample of the types of testing that will be conducted:
   1) Validation of E-Stop and limit switches
   2) Validation of operational speeds
   3) Validation of travel limits
   4) Validation of target achievement & repeatability
   5) Observe motion during E-Stop Activation
   6) Observe motion during instantaneous loss of power (bang stop)

b. Contractor shall coordinate the site so as to ensure testing can be done in a well-lit, clean, safe environment, including barricades to ensure unauthorized persons are not able to interfere with the testing. No temporary wiring or transformers will be allowed during the CTP.

c. Contractor shall provide test weights delivered, manipulated for testing, and removed from site. Provide floor protection as required during CTP.

1) Provide sufficient quantities of weights to test each motor drive element to 125% of capacity.

d. All costs associated with the CTP are the responsibility of the Contractor; this includes items such as equipment necessary to access the hoists to ensure limits and brakes can be tested.
3.6 ADJUSTING

A. Adjust all equipment and components for operation in accordance with the specifications, approved shop drawings and pertinent Contract Drawings prior to the demonstration indicated herein.

B. Upon installation and in accordance with the Owner’s schedule, all draperies shall be given an adequate “hang-out” period prior to final acceptance. Steam-out of wrinkles and creases will only be permitted with prior approval.

3.7 CLEANING

A. Touch up minor abrasions and imperfections as required.

B. Remove from the premises all debris caused by this work. All unnecessary equipment and materials shall be removed from the area(s) of this work upon completion, removed from the job site and disposed of legally at no additional cost to the Owner.

3.8 CLOSEOUT ACTIVITIES

A. Demonstration
   1. Upon completion of Commissioning, the Contractor will notify the Theatre Consultant that the system is complete, conforms to specification and is ready for Demonstration.
   2. Installed equipment to be operated for approval and inspected for quality by the Theatre Consultant, the Architect and the Owner.
   3. The Theatre Consultant will observe the CTP on each hoist unit during the equipment Demonstration.
   4. Adjustments or modifications shall be made as directed by the Architect and the Theatre Consultant.
   5. Costs of re-inspection and additional testing by the Architect and Theatre Consultant, if required, due to lack of completion and/or errors and omissions shall be paid by the Contractor. This work will be conducted on a time and materials basis, including the Architect’s and Theatre Consultant’s standard hourly rates, and shall be scheduled and approved in writing prior to the re-inspection/testing session.

B. Training
   1. Following the equipment demonstration, inspection and final adjustments, provide instruction to the Owner’s staff or representatives on the safe operation, care and maintenance of all items.
      a. Instruction must match information provided at the time of submittals and shall include, but not be limited to, proper general maintenance of the system, replacement procedures for user replaceable parts, and operating procedure to obtain maximum usage of system.
      b. Deliver all copies of approved Operations Manual to Owner prior to first instruction session, and review it as part of that session.
   2. Motorized Rigging Instruction:
      a. Provide in-depth instruction to Owner or Owner’s designated staff on the detailed operation of motorized hoists, control elements and associated devices. This training shall take place in two separate sessions.
   3. Timing for all sessions shall be scheduled by the Owner at their convenience.
   4. Instruction must be by qualified expert operators who have actual experience with systems in performance conditions.
5. At the conclusion of the training the Contractor shall conduct a written and hands-on test of the participants that shall demonstrate to the Contractor that the participants have reached a level of understanding that will result in safe use of the equipment.
   a. Provide Certificates of Training for each participant. Log the names of those who successfully completed the training process. Submit as the first page of the bound material.

6. All training shall be videotaped, by the Contractor, for the training of future employees and students.

3.9 PROTECTION

A. Provide full protection from damage, construction dirt and debris for all equipment from the point of installation to testing and commissioning.

B. Remove all equipment protection and clean components thoroughly prior to the demonstration session.

3.10 MAINTENANCE

A. Maintenance Services
   1. One month prior to the end of the first year following the date of final systems acceptance, a factory engineer shall be provided to examine, adjust and repair the equipment included in this section as required. This service shall not cover adjustments, repairs or replacement of parts due to negligence, misuse, abuse or accidents caused by persons other than the Contractor. All labor and materials which are required to perform this service shall meet or exceed these specifications and shall not compromise the performance of the equipment in any way.

   2. Following this inspection and maintenance service, the Contractor shall provide the Owner and Theatre Consultant with a written report itemizing the results of the inspections and the warranty work that was conducted. The Contractor shall also include in this written report recommendations for any corrective actions which the Contractor feels should be taken with respect to the equipment included in this section but are outside the scope of the warranty agreement.

   a. The report of the one year inspection shall be furnished within fifteen days of the inspection. It shall indicate the findings, recommendations, revised maintenance procedures, etc.

B. System Programming Updates
   1. Contractor shall review system operation and control system programming with the Owner’s representatives. Any required adjustments and changes to the control system programming requested by the Owner shall be performed and completed during the time of the corrective service site visit. All control system programming changes shall be documented by the Contractor.

C. Maintenance Contract
   1. Provide to the Owner an executed yearly maintenance agreement for a total of 5 years. This agreement must include, but not be limited to:

      a. Visual inspection of each hoist and all associated loft blocks, idlers, mule blocks, wire rope, connections, etc.
      b. Upgrade, if available, to the latest release of the software compatible with the existing control system.
      c. Network data distribution inspection.
d. Re-training of existing personnel and new training of new personnel. This training is to be at the same level or better than the original training.

e. All material, components, accessories and services required to provide the work as specified herein.

3.11 ATTACHMENTS

A. Refer to Appendix A of this section for quantities and accessories.

END OF SECTION 11 61 33
SECTION 116135

STAGE EXTENSION – ORCHESTRA PIT LIFT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. The work in this section includes Stage Extension - Orchestra Pit Lift systems and equipment within the following space:
   1. Proscenium Theatre

B. Section Includes
   1. Major Systems and Equipment: furnish and install the following major elements and associated accessories:
      a. Motorized orchestra pit lift
         1) Cable Management
         2) Rigid skirt with safety net
      b. Orchestra lift controls
      c. Safety devices
         1) Removable safety railing frames and sockets with interlock switch
         2) Astragal safety tape switches
         3) Access hatch
         4) Door interlocks
         5) Edge of audience infill assembly
      d. Storage carts for removable safety railings
      e. Training
   2. Work Results:
      a. The equipment installed as part of this Section shall result in a complete and working orchestra pit lift system in each space.
      b. Provide fully coordinated and engineered equipment, installation, supervision and commissioning for the systems and associated accessories as required for each space.
      c. Provide supervision of orchestra pit lift system low voltage signal cable pulling, termination and testing by the Division 26 Electrical Contractor.
      d. Provide coordination of conduit, backboxes and AC power wiring provided by the Division 26 Electrical Contractor.
      e. Provide all material, components, accessories and services required to provide the work as specified herein, elsewhere in the Contract Documents and/or as shown on related drawings.
      f. Consult and coordinate with other affected work and Contractors throughout the course of the work contained herein.
   3. Delegated Design:
      a. Provide design for the means of fastening, suspension and support of the work of this Section.
      b. Provide all material, components, accessories and services required to provide the work as specified herein, elsewhere in the Contract Documents and/or as shown on related Drawings.

C. Products Supplied But Not Installed Under This Section
   1. The following equipment supplied under this Section shall be installed and/or terminated under Division 26:
a. Motors
b. Motor disconnect switches
c. Motor Control Center (MCC)
d. Terminal boxes and flexible cable from machinery pit to orchestra lift platform.
e. Lift control system devices including but not limited to control panels, E-stop stations, and control connection stations.

2. Termination of control system conductors shall be made by Division 26 under the direct onsite supervision of the Contractor.

3. Controls, limit switches, safety interlock system devices (including rocker arm limit switches, astragal tape switches, door interlocks, removable rail interlocks, etc.) are installed under this Section. Final terminations to the devices are made under Division 26.

D. Related Requirements
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications apply to this Section.
2. Examine Contract Documents for requirements that directly affect or are affected by Work of this Section. A list of those Documents and Sections includes, but is not limited to the following:
   a. Division 01 – General Requirements
   b. Division 03 – Concrete
      1) Fastener requirements
   c. Division 04 – Masonry
      1) Fastener requirements
   d. Division 05 – Metals
      1) Structural steel supporting the work of this section.
   e. Division 09 – Finishes
      1) Flooring
         a) Finished floor and any additional framing on top of lift superstructure required for floor support (see Architectural Documents).
      2) Millwork
         a) Removable railings finish surface (see Architectural Documents).
         b) Lift fascia (see Architectural Drawings)
   f. Division 11 – Equipment
      1) Section 116133 – Theatrical Rigging
      2) Section 116163 – Theatrical Lighting Dimming and Control
   g. Division 12 – Furnishings
      1) Section 127100 – Portable Audience Seating
   h. Division 26 – Electrical, including but not limited to:
      1) Section 265561 – Theatrical Systems Electrical Requirements
      2) General requirements for all Electrical work, including installation of system cable trays, terminal cabinets, empty conduit, junction/pull boxes and back boxes for system devices and panels (Division 26).
      3) Electrical terminations (AC power and grounding only) to all equipment racks and AC power receptacles (Division 26).
      4) Provision and installation of all conduit and back boxes (Division 26).
      5) Electrical services and main circuit protection (Division 26).
      6) Distribution system equipment (Division 26).
      7) Conduit, wire, pull boxes, junction boxes and miscellaneous hardware and components as required for a complete electrical installation.
      8) Terminations and testing of system continuity.
1.2 PRICE AND PAYMENT PROCEDURES

A. Refer to Division 01 – General Requirements for information regarding price and payment procedures.

B. Unit Prices
   1. Provide price to Owner for five year maintenance agreement on motor drive elements. Price to include emergency site service (post warranty period), one one-day session of additional operator training per year, and replacement of parts due to failure under normal usage.

1.3 REFERENCES

A. Definitions
   1. The following definitions are relevant to this Section and are in addition to those defined in Division 01 – General Requirements:
      a. In all cases where a device or a part of equipment is referred to in a singular manner within the contract documents, it is intended that such a reference shall include all devices required to complete the installation in accordance with the project documents.
      b. "Architect": All references to the "Architect", Hamilton Anderson Associates, will refer to the process by which the indicated action or decision regarding the work in this section will be administered. All such actions shall be initiated with or by the Project Architect, who will disseminate all pertinent information and documents to, as well as coordinate all efforts and site visits with, the Theatre Consultant and all other project consultants who may have design responsibility relating to the work in this section.
      c. "Theatre Consultant": Auerbach + Associates, Inc. (d.b.a. Auerbach Pollock Friedlander). The Theatre Consultant will be party to all actions and decisions regarding the work in this section.
      d. "Other Project Consultants": Acoustical Consultant, Electrical Engineer, Structural Engineer or Mechanical Engineer as is applicable to a particular issue.
      e. "Contractor": Manufacturer/Installer responsible for the fabrication and installation of the work contained in this section.
         1) Contractors involved with other portions of the work shall be indicated with a specific trade preceding the word "Contractor" (i.e. General, Electrical, etc.).
      f. "Owner": Authorized personnel representing Wayne State University.
      g. "Furnish": Purchase and/or fabricate and deliver to project site.
      h. "Install": Physically install the items in their proper location(s) on the project site.
      i. "Provide": Furnish and install unless otherwise indicated.

B. Reference Standards:
   1. Reference Division 01 for general project references and standards.
   2. References to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies will refer to the latest edition of such publications adopted and published prior to submittal of the bid. All such codes and standards will be considered a part of this specification as if they were fully included herein.
   3. If an applicable code or standard permits work of lesser quality or extent than this specification, then this specification and the related drawings will govern.
   4. Comply with national, state and local codes.
   5. Comply with national, state and local labor regulations and requirements.
   6. The following standards apply to the work of this Section. It remains the Contractor's responsibility to confirm and comply with all industry standards that are applicable to the work of this Section.
STAGE EXTENSION ORCHESTRA PIT LIFT SYSTEM

Gateway Theater Complex
HAA Project No. 2016034.00
WSU Project No. 189-178578

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. The Contractor is required through drawings, memos and meetings to properly coordinate the work with the other sections as necessary to complete the work of this section.

B. Pre-installation Meeting:
1. Refer to Division 01 - General Requirements for information regarding pre-installation meeting with the General Contractor.

C. Sequencing
1. The installation of the equipment in this section shall be coordinated with other work which may be in conflict with or which must be completed before the work in this section may be installed, including:
   a. Principal foundation work (see Structural Drawings)
   b. Installation of associated electrical work (see Electrical Drawings)
   c. Installation of HVAC work in ceilings (see Mechanical Drawings)
   d. Painting
   e. Finishing of floors and finishes
   f. Electromechanical and electronic equipment installation shall proceed after environmental site conditions are met. Refer to paragraph 1.10-B for class requirements.

D. Scheduling
1. The Contractor shall submit a project schedule (critical path) at the time of contract negotiation, which shall indicate coordinated functions with other trades and project requirements.

1.5 ACTION SUBMITTALS

A. All submittals shall be submitted in accordance with Division 01.

B. All submittals shall be submitted in a timely manner, allowing sufficient time for adequate review and possible resubmittals without jeopardizing project schedule.

C. Submittals will be reviewed, accepted and field dimension verified prior to proceeding with the fabrication of the work in this section.

D. All submittals shall leave space available for review stamps and comments.

E. The Architect and Theatre Consultant shall only mark one set of drawings per submittal with comments. Any additional sets of drawings or product data shall be returned unmarked.

F. Provide insurance against loss or damage during shipment. Furnish certifications of such coverage to the General Contractor not less than 60 calendar days prior to the shipment of any equipment.

G. Review all pertinent project Contract Documents. Following this review, provide to the Architect and General Contractor any additional information required to make a fully functioning system. In addition, the Manufacturer shall indicate maximum accepted wire size as it relates to termination points on their equipment.

H. Verify wire type, count, and routing for all required data wiring between all components to allow for proper conduit sizing and routing by Division 26. Verify and coordinate all line voltage power input required by systems components that shall be provided under Division 26.

I. Prior to fabrication, it shall be the responsibility of the contractor to provide a complete submittal for approval within 90 days of award of contract.

J. Product Data
   1. Where standard manufacturer parts are used, submit current product literature describing component, manufacturer’s recommended applications, load ratings, safety factors and dimensions. The data shall include all information which indicates compliance with the specifications herein.
   2. Clearly indicate specific component and applicable options.

K. Shop Drawings
   1. Provide shop drawings on D size minimum (24” x 36”) sheets.
   2. Include a cover sheet with a drawing index including the sheet number and title for each sheet in the set.
   3. Provide \( \frac{\pi}{4} = 1’-0” \) plans of all locations which contain equipment in this contract. Show all equipment properly located, dimensioned and labeled. Note all work by others in the vicinity, which may affect work in this Section.
   4. Provide complete, fully dimensioned, large scale detailed fabrication drawings of all major components.
   5. Provide requisite schematics, plans and sections indicating assembly and installation of components.
6. Provide indications by arrow and boxed caption of all variations from contract drawings and specifications, except where variation is indicated as acceptable.
7. Indicate all elements with appropriate safety factors and/or safety equipment.
8. Indicate recommended load limits for each element in the system with loading requirements.
9. Provide power requirements, one-line riser diagrams and installation circuit diagrams for electrical equipment. Show all required wire sizes and counts between all components. These shall be provided within 30 days of Contract Award.
10. Provide a full Bill of Materials to be supplied, including quantities, manufacturer’s part number, reference to applicable drawings, etc.

L. Samples
1. Submit sample items including, but not limited to:
   a. Control switches and panel materials
   b. Astragal tape switches
   c. Lift guide rail and block
   d. Interlock switches/sensors
   e.
2. Additional samples must be submitted within 14 days Architect’s written request.

M. Delegated Design Submittals
1. Provide drawings and calculations meeting the review requirements of the authorities having jurisdiction, stamped and wet signed by a Professional Engineer licensed in the project jurisdiction for work of the specific type performed.
2. Where standard components are used, manufacturer’s engineering data shall be provided to supplement engineered calculations.
3. Engineered drawings shall be provided to the Architect and Theatre Consultant for review of coordination and compliance to this Section.
4. Engineered drawings shall be provided to the Structural Engineer of record for this project. The engineer of record will review the loads imposed on the structure by this equipment and compare those loads to allowable structural loading.
5. Engineered drawings shall be provided to the Authority Having Jurisdiction for this facility. The AHJ will review the drawings for compliance with local codes. In all cases code compliance is the responsibility of the Contractor.

N. Manufacturer’s Instructions
1. Installation Instructions:
   a. Supply installation instructions for all items furnished in this section, as reviewed and approved with shop drawings, to Electrical Contractor and General Contractor. Such instructions shall be fully coordinated with trades doing adjoining work and with site conditions. Instructions shall include inter-equipment connection diagrams with terminal designations.

O. Manufacturer’s Reports
1. Installation Inspection Reports:
   a. Supply reports confirming that all elements of installation by Division 26 conform to requirements of the Orchestra Pit Lift System as engineered and specified herein. Submit these reports to the Architect at times required by the Schedule of Submittals.
   b. If conditions exist that are contrary to proper installation of the Orchestra Pit Lift System, directly inform Contractor, Architect, and Theatre Consultant of discrepancies. Failure to inform the Contractor shall constitute acceptance of installation and place responsibility for any revisions or additions necessary to properly install work of this section, with the Manufacturer.
2. Provide periodic video recordings of production of material to demonstrate progress of work. Video schedule shall be indicated in the Contractor's critical path.

P. Source Quality Control Submittals
1. The Contractor shall supply as part of the submittal process the following Source Quality Control documents which must contain, at minimum:
   a. Serial number of motor(s)
   b. Serial number of lifting column(s)
   c. Motor drive serial number
   d. Batch number of major components
   e. Name of person conducting the QC test
   f. Date the test was conducted
   g. List of mechanical tests conducted
   h. List of electrical tests conducted

1.6 CLOSEOUT SUBMITTALS
A. Project Record Documents:
   1. Submit documents in accordance with Division 01 – General Requirements.
   2. At the time of acceptance testing, submit three (3) copies of parts lists and maintenance instruction sheets.
   3. Within 60 days of the acceptance testing, submit one (1) set of reproducible "as built and approved" drawings showing all equipment as installed. These drawings shall include all adjustments made during the checkout process.
   4. Submit operation and maintenance manuals with the “as built and approved” drawings. Each manual shall be bound in an individual binder with the project name on the front cover and system identification on the spine. The manuals shall include:
      a. Complete parts list for all equipment and telephone numbers for the authorized parts and service distributors.
      b. Instructions as to the safe operation for all equipment.
      c. Recommended maintenance schedule for component parts that may need periodic replacement or maintenance.
      d. Recommendations for cleaning, maintaining and touch-up of all finished surfaces.
      e. Deliver all copies of approved Operations Manual to Owner during instruction session, and review it as part of that session.
   5. Where specific elements do not require manuals, instruction sheets as to care and handling shall be provided.
   6. Warranties as required herein.

B. Submit verification that all punch list items have been rectified. Such written verification will be required for project closeout and initiation of the warranty period.

C. The record documents shall be reviewed by the Architect and all modifications to the documents stemming from this review shall be made as required.

D. Above submissions are required as a condition for final approval of the work.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Spare Parts:
   1. Deliver stock of maintenance material to Owner. Furnish the following to match those installed and taken from the same production run, packaged with protective covering for storage and identified with appropriate labels:
a. (2) Spare fuses of each type used in the system
b. (6) Indicator lamps of each type used in the system
c. (2) Relays of each type used in the system
d. Machinery lubricant

1.8 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Refer to Division 01 – General Requirements.

B. Qualifications
1. All equipment and installation to be the responsibility of a single Contractor, who shall own and operate their own manufacturing facility for the fabrication, assembly and integration of theatrical lift equipment, and be regularly engaged in the fabrication of such equipment. Fabrication of such equipment shall comprise no less than 90% of the Contractor’s business.
2. The Contractor’s Project Manager shall be qualified and have experience in projects of similar size and scope. The Project Manager shall have binding authority to represent and act for the Contractor. The Project Manager shall be the primary conduit for all information between the supplier of this equipment and the General Contractor. All information given to the Project Manager shall be considered as given to the Contractor.
3. The Contractor shall have been continuously engaged in the fabrication, integration and installation of theatrical lift equipment for no less than ten years.
4. The Contractor shall have, at the time of bid, a current Contractor’s license and shall know, understand, and have the required documentation to work in the State of Michigan. This license shall be maintained throughout the course of the work of this contract.
5. Contractor shall be responsible for proper installation, operation and safety of all component equipment.
   a. Equipment must be procured as specified. Non-specified items may be procured from any nationally recognized manufacturer.
   b. Metalworking may be done by others. Responsibility in all respects shall be that of the Contractor.
6. The Contractor shall verify all system design loads.
7. Errors and omission within the Contract Documents shall not relieve the Contractor and the General Contractor of the responsibility of providing a properly functioning installation of the system as described herein.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage and handling shall be coordinated with the General Contractor and shall meet all requirements described in Division 01.

B. Packing, Shipping, Handling and Unloading
1. All equipment shall be appropriately and substantially packed for shipment.
2. All equipment containers shall clearly indicate the equipment contained, “front”, “top”, “fragile”, the project name, and theatre site allocation. Include packing and shipping lists for each container.
3. All shipping costs to the job site are the responsibility of the Contractor. The shipping method/company is at the total discretion of the Contractor in order to meet the published project schedules.

C. Acceptance at Site
1. Coordinate responsibility for acceptance of material and equipment at job site with the General Contractor.

2. The Contractor shall be responsible for acceptance of the Theatrical Lift System components at the job site, confirming that all quantities and counts are correct and for keeping accurate logs and records of such information.

D. Storage and Protection

1. Upon delivery, the materials shall be stored under cover in a dry and clean location, off the ground. Delivered materials which are damaged or otherwise not suitable for installation shall be removed from the job site and replaced with acceptable materials.

2. Replace, at no expense to the Owner, all equipment and materials which are damaged during storage or handling.

1.10 SITE CONDITIONS

A. Existing Conditions

1. Verify all conditions at job site. Promptly report variations and obstructions to the Architect. All additions and or corrections are to be requested prior to fabrication.

B. Environmental Requirements

1. Equipment is classified according to its susceptibility to construction conditions that may affect its operation. Classes shall be defined by the following paragraphs:

   a. Class 1:
      1) Cable and distribution apparatus, structural elements, electrical back boxes, face plates, terminal boxes, and empty equipment rack frames may be stored in weather protected spaces under "normal" construction site conditions provided that no electronic components are contained within devices, storage boxes are sturdy and well-sealed, and equipment is protected with imperforate inner plastic sheeting.
      2) Contractor may install this class of equipment in weather-protected spaces under "normal" construction site conditions provided that equipment is protected from dust and moisture by sturdy imperforate plastic sheeting and completely covered with corrugated cardboard held securely in place by duct tape. Cardboard covers shall not be removed until area is broom cleaned. Under no circumstances shall equipment remain uncovered overnight during installation or while work which causes high dust or moisture levels in area of placement is taking place.

2. Class 2:

   1) Control panels, spare parts, test and other equipment (except as listed under Class 3) not subject to damage by concrete dust or dirt shall be stored and protected per Class 1 devices.

   2) Contractor shall not install equipment in this class until area of installation is broom cleaned, "blown" clean with pressurized air, mopped, air conditioned and secure. Contractor may install control panels with electronic components under Class 1 conditions, but electronic components must be removed and not installed until area of installation meets Class 2 conditions.

3. Class 3:

   1) Control consoles, filled equipment racks and other electronic equipment shall not be shipped to site until the rack and control rooms are finished, air conditioned, dust free, broom and mop cleaned, secure, and in all respects complete and ready for occupation.

   2) This class of equipment shall not be unpacked until the system is complete in all other respects. Under no circumstances may any equipment in this class
be removed from the rack and control rooms into or through spaces which are not cleaned, air conditioned, and complete.

C. Field Measurements
   1. Field measurements shall be taken prior to preparation of shop drawings and prior to fabrication to ensure proper fitting of work. Allow for adjustments during installation whenever taking field measurements.
   2. Should field measurement of site conditions alter the design or installation of system elements from the approved shop drawings, revised shop drawings shall be reissued for review.

1.11 WARRANTY

A. Comply with the warranty requirements of Division 01 and following.

B. The Contractor shall warrant materials and workmanship of systems and equipment installed as free of defects. The Contractor shall guarantee in writing the repair or replacement within 14 days of any item found defective during a period of one (1) year following date of final acceptance. Ordinary wear and defects due to improper usage are excepted.

C. The Contractor shall warrant the workmanship of the installation services provided under this Section for a period of one (1) year following the date of final acceptance. Ordinary wear and damage due to improper usage are excepted.

D. During the warranty period, all emergency conditions where systems failures may be hazardous or may cause severe hardship or cancellation of performances shall be responded to within 24 hours. Immediate action shall be undertaken to ensure the safety of the audience and the performers.

E. During the Warranty Period, for each product that uses software, furnish manufacturer’s software updates to the Owner for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. To establish comparative standards of quality, the equipment and installation indicated herein shall be by one of the following manufacturers:

   Gala Systems Inc.
   3185 First Street
   St-Hubert, QC J3Y 8Y6
   Canada
   Tel: (450) 678-7226

   Serapid USA Inc.
   34100 Mound Rd
   Sterling Heights, MI 48310
   Tel: (586) 274-0774

B. Substitution Limitations
1. Any contractor who wishes to be listed and has not been pre-approved must submit qualification information to the Architect. Proposal shall include all of the information listed below:
   a. Statements of financial responsibility for the past five fiscal years showing assets and liabilities.
   b. List of principal officers and design and service engineers in an organizational structure flow chart.
   c. List of not less than 5 projects of similar size and scope completed within the five years on which contractor has provided full services: product engineering, shop drawings, manufacture, installation and commissioning. In each instance, indicate specifics of scope of fabrication and installation. Include a contact list: name, address and phone numbers of person(s) directly responsible for operation and maintenance of equipment in each facility.
   d. List of current projects and approximate contract value and completion dates. Include list of names, phone numbers and addresses of owner, owner's representatives and architect.
   e. For each above described project, list of names of persons who supervised preparation of shop drawings, manufacture of components, and installation of equipment.
   f. List of names of persons who would do project management, product engineering, supervision of shop drawing, supervision of installation should this contract be awarded.
   g. Contract Bond Company information indicating that Contractor has bonding capacity for full duration of project. Include list of other bonded projects coinciding with this project.
   h. Evidence of ability to undertake custom product engineering to meet specific requirements of project specifications. Provide sample project engineering drawings for custom products and contact information for facility operators where those products have been installed.

2. Standards of Acceptance:
   a. Refer to Paragraph 1.8B - Quality Assurance/Qualifications.

2.2 SYSTEMS DESCRIPTION

A. The following performance spaces shall contain the following major systems components listed below and as shown on the TE-series drawings:
1. Orchestra Pit Lift
   a. The orchestra pit lift shall be built as a continuation of the stage floor, with predetermined stops to serve as a show deck, stage extension, an audience seating area with removable seats, and an orchestra pit. The finished floor shall be by Flooring Contractor. Coordinate adequate steel framing and subfloor support for the floor detail shown on the Architectural drawings with the Flooring Contractor.
   b. Cable management shall be provided for any flexible cabling between the machine pit and the orchestra lift platform.
   c. The underside of the lift shall have a rigid skirt with safety net on upstage side.
2. Controls
   a. Lift controls shall be located as indicated in the drawings. Controller shall be a handheld pendant on an umbilicus, which shall plug into a receptacle located at the Production Control Panel (PCP) or at orchestra pit level.
3. Safety Devices
   a. The orchestra pit lift shall be provided with removable, socketed safety railings as shown in the drawings. Coordinate railing frame fabrication with details in Architectural drawings. Provide rolling steel tube storage carts.
b. Shear edge protection and interlocks at doors, railings, and access hatches to be provided as indicated in the drawings.

B. State of the Art Development
1. The Contractor shall furnish only the manufacturer’s latest developed appropriate products. In cases where product development from a specified manufacturer surpasses the criteria of this specification, the Contractor shall inform the Architect and make the newer product available to the Owner for acceptance. In no case shall discontinued or obsolete equipment be acceptable. Should a newer product be suggested as a substitution for a discontinued product, or for a product that is in process of being phased out of production, that newer product shall be offered to the Owner at no additional cost.
2. Should product recall by the Manufacturer require temporary or permanent replacement of a product specified under this section, the Contractor shall notify the Owner at the earliest reasonable time and shall arrange to replace the product in question at the earliest possible time.
3. Equipment found defective or subject to recall prior to scheduled installation shall not be delivered to the job site.
4. Equipment defect or intended recall shall not relieve the Contractor from his contractual obligation with regard to delivery schedule of product. In this circumstance, notification shall be made to the Architect by express carrier. Arrangement for alternate product shall be made at this time.

C. Substitutions
1. All requests for variations from the specified materials and products will be reviewed by the Architect and Theatre Consultant according to the procedures outlined in Division 01.
2. All requests for substitutions must be submitted in a timely manner, so as not to adversely impact the project schedule.
3. Substitutions will only be accepted if, in the opinion of the Architect, the product is an equal to the specified product. No substitutions may be made without written acceptance from the Architect. All substitutions made prior to this acceptance are at the sole risk of the Contractor.
4. A substitution must be a product of equal design, construction and performance. The Contractor must submit all pertinent information required to substantiate that the product is equal. The Contractor must submit all additional information, including test data, which may be requested in order for the Architect to fully evaluate the substitution. The burden of proof is solely on the Contractor.
5. All additional expenses of any kind with respect to substitution(s) shall be borne by the Contractor. This shall include, but not be limited to, all fees and expenses incurred by the Architect and other related Consultants for evaluation of the substitution and subsequent integration into the project should the substitution be taken and/or additional costs of other contractors related to the substitution(s).

2.3 MATERIALS
A. General
1. All equipment and components shall be new and complete. No used or reconditioned equipment shall be acceptable unless otherwise noted.
2. All equipment to have pertinent labels.

B. Materials shall conform to the following minimum standard specifications:
1. AISI 1045 for steel shafts
2. ASTM A36 for structural steel shapes
3. ASTM A47 for malleable iron casting
4. ASTM A48 for gray iron casting
5. ASTM A1011 for side plates
6. ANSI B18.2.1&2 for square and hex bolts and nuts

C. Hardware
1. All mounting hardware to be included.
2. All bolts and fasteners must be Grade 5 or better.
3. All bolted attachments to have lock washers or other self-locking fasteners.

D. Electrical
1. All internal wiring shall be factory completed and clearly marked. All field connections shall be by compression connector, terminal strip or other device specified herein. All terminal strip connections shall be clearly labeled as to terminal designation. Insulated wire ferrules are to be used whenever possible for wire termination. Wire nut splices not permitted.
2. All wire sizes and insulation to comply with Underwriters Laboratory and all applicable standards and local codes.
3. All wiring to be harnessed and bound. No loose or randomly routed wires shall be permitted.

E. Design Factors
1. Contributing static loads x 7.0 for structure and all supporting and mechanical components; x 3.0 for drive components.
2. Static deflection of structural spans shall adhere to a criteria of L/720.
3. All drive components shall be designed with a safety factor 3X.
4. Bearings shall be designed with a 2X rating, full speed / 2000 hours.

F. Finishes
1. Machine-finish all operating parts to standard trade tolerance, fits and finishes.

G. Electronics
1. All microprocessor controls shall utilize a non-volatile memory. System configuration, operating parameters, presets, etc. shall be protected against system power failure indefinitely.

2.4 ORCHESTRA LIFT

A. Operating Criteria
1. Electro-mechanical Lifting Mechanism (Option 1):
   a. Spirailift by Gala
2. Electro-mechanical Lifting Mechanism (Option 2):
   a. Linklift rigid push chain columns by Serapid
3. Travel Speed: 8 feet per minute
4. Sustaining Capacity: 150 PSF live load
5. Lifting Capacity: 50 PSF live load
6. “Point Load” Capacity: 750 lbs. castered wheel load
7. Vertical Drift: 0 under full load
8. Programmed Stops:
   a. Show Deck Level (+6” above Stage Level)
   b. Stage Level
   c. Alternate Stage Level
   d. Audience Level
   e. Orchestra Pit Level
   f. Basement Level
9. Total Travel
   a. 12’-6”
10. Over-travel
   a. Proper over-travel is required to ensure a safe stop can be achieved.
      1) The lift shall not strike the initial limit if all system components are operating normally.
      2) The lift shall not strike the ultimate limit if a deceleration stop was initiated by striking the initial limit.
      3) The lift shall not strike any hard surface (building or lift structure) if a deceleration stop was initiated by striking the ultimate limit.

11. Power Supply: 208VAC, 3-Phase, 60Hz (confirm with electrical contractor)

B. Structural Framing
   1. The superstructure of the lift shall be provided as indicated in the drawings.
   2. All framing and structural support members shall be of steel construction, sandblasted, primed with rust inhibitor, and painted with two coats of black enamel.
   3. Static deflection of structural spans shall adhere to a criteria of L/720.
   4. Steel tube stringers on superstructure to accept finished stage floor by others. Coordinate with General Contractor.
   5. Provide steel angle perimeter frame support to accept finished fascia by others. Coordinate with General Contractor.
   6. Coordinate lift structure and fascia with General Contractor to ensure that finished edges of lift have no more than 3/16" clearance to adjacent surfaces. See Drawings for details.

C. Audience Edge Infill
   1. Provide infill framing and cover at edge of audience slab as shown on the drawings. It is the design intent that the manufacturer of the orchestra pit lift will control the intersection point between the audience edge and the lift.
   2. The infill floor shall incorporate sockets and interlock switches for removable safety railing.
   3. The infill floor shall include removable cover sections to allow access to interlock switches for inspection and maintenance.

D. Drive System
   1. General
      a. The mechanical system shall consist of electro-mechanically driven lifting columns mounted to the machine room floor as indicated in the drawings. There shall be two motors and floor-mounted miter gearboxes. Provide intermediate shaft supports as necessary.
      b. Provide enclosure to protect and house the lifting elements from entry of foreign materials and prevent the collection of debris in the machinery.
      c. Vertical drift under full static and live load shall be zero.
   2. Electro-mechanical Lifting Mechanism
      a. Spiralift Columns (Option 1)
         1) Provide Spiralift columns as indicated in the Drawings.
         2) Top of Spiralift attachment with reaction plate bolted to the lift superstructure.
         3) Provide pressure plate with compression load sensor at top of Spiralift to ensure constant compressive loading on all columns. Compression load sensors shall disable power to the system before the compression load is completely relieved in order to prevent a catastrophic failure of the column.
         4) Provide base plate with mounting angles for attachment to the machine room floor.
         5) Spiralift worm gear:
         6) The column shall be driven by a worm gear that is engineered to resist the loads with the appropriate safety factors as described herein.
         7) Provide Spiralift columns by Gala Systems, sized as required to meet operating criteria as indicated above and in drawings
      b. Rigid Chain Columns (Option 2)
1) Provide rigid push chain lifting columns as indicated in the Drawings.
2) Drive mechanism shall be inherently self-locking regardless of the elevation or load imposed.
3) Provide rigid chain storage magazine cover.
4) Front of chain attachment with reaction plate bolted to the lift superstructure.
5) 90 degree reaction base plate with mounting angles for attachment to the machine room floor.
6) The columns shall have flexible dust / debris cover at the top chain input port.
7) Linklift Chain gearbox
   a) The chain shall be driven by a planetary gear box that is sized to resist the loads with appropriate safety factors as described herein.
8) Provide Linklift columns by Serapid, sized as required to meet operating criteria as indicated above and in drawings.

3. Drive Mechanism:
   a. Gearboxes
      1) Power shall be transmitted to lifting columns via drive shafts and right angle bevel gearboxes via drive shafts.
      2) A 90 degree miter gearbox shall be provided at right angle transitions in the drive train.
      3) Pedestals and support for gearbox and drive shafts are under the work in this Section.
      4) All stepped-down shaft corners and shoulders shall have proper corner radius.
      5) The gears shall run in an oil bath.
      6) The shaft bearings shall be provided with double-lip oil seals to prevent leakage.
      7) The gear box shall be sized to resist the loads with the appropriate safety factors as described herein.
      8) Provide spiral-bevel type gearbox by Andantex or pre-approved equal (Hubcity shall not be accepted)
   b. Shaft Couplings:
      1) Flexible couplings, shaft and bearing blocks shall be provided as required.
      2) All shaft connections shall be flexible spline/gear type. Chain couplings are not acceptable.
      3) Shafts shall be supported by an intermittent pillow block support assembly as required.
      4) The shaft couplings shall be sized to resist the loads with the appropriate safety factors as described herein.
   c. Shaft
      1) Connecting shafts shall be sized to limit twist to 0.001 degree per foot at maximum torque over full length of shafting. All shafting, keys and keyways shall be in accordance with ANSI "Code of Design of Transmission Shafting" to safely transmit all applied loads, torques and their combinations, with proper allowance for impact loading and to satisfy critical speed and torsional deflection requirements.
   d. Pillow Blocks
      1) Shafts shall be supported by heavy duty spherical roller bearing pillow blocks, with sealed ball bearings.
      2) Pillow blocks bolted to support frame with bolts, nuts and lock washers.

4. Lift Motor:
   a. Size and capacity as described herein.
   b. Operating speed of the lift shall be consistent whether the lift is fully loaded or unladen.
   c. The motor shall be NEMA class D designed for three-phase operation with soft start and high starting torque characteristics.
d. Service factor of 1.25 for continuous operation and an AGMA load classification of 1. All motors shall be totally enclosed and fan cooled. Motors shall have ramp start and stop.

e. Motor shall have flux vector type drive.

f. Motor brakes shall be normally closed, direct acting, spring loaded, electrically released, and equipped with a manual release. Brakes must stop and hold 200% of the full load torque on the motor shaft.

g. Shafts to be keyed and fixed with double set screws and positioned with locking collars.

h. Exposed shafting and couplings shall be properly supported with bearing blocks to provide quiet operation. Speed shall not exceed 25 rpm.

i. Motor support to be rectangular tube frame bolted to pit slab as indicated in Drawings.

j. Verify and coordinate power requirements with Electrical Engineer.

k. Provide Conedrive, SEW Eurodrive or equal.

E. Guides

1. The lift shall be provided with guides to control lateral movement in all directions at all levels.

2. Guides shall be Thomson linear motion shaft bearings as shown on the drawings. Elevator "tee" guides are not acceptable. Precision guides shall be hardened steel.

3. Lateral movement shall be nil and controlled so as to allow no more than 3/16" gap between the lift and adjacent structure.

4. Provide a flexible but positive closure over all guide slots in order to conceal slots from view and prevent physical access from personnel on the lift. Closure shall be neoprene strip split to allow guide arm to travel freely.

5. Guide rails to be mounted to support plates with threaded bolt assembly that allows for vertical/ horizontal field adjustment.

F. Positioning

1. Position feedback will be by absolute encoder.

G. Limit Switches

1. Provide lever operated hatchway type limit switches for a minimum of up and down, initial and ultimate limits. Mount limit switches at guide arm.

H. Cable Management

1. Provide cable management system and associated flexible cable for the orchestra lift.

2. Furnish terminal box mounted to floor of the machine pit, for installation by the Electrical Contractor.

3. Provide terminal box mounted to the orchestra lift platform.

4. The Contractor must provide all cable management between the terminal boxes on the machine pit floor and on the orchestra lift platform.

2.5 CONTROLS

A. Lift controls shall be by a handheld touchscreen control pendant on a 50'-0" umbilicus with constant contact "UP" and "DOWN" pushbuttons and an "Emergency Stop" mushroom button. The emergency stop shall remove power to the motor drives. Reset shall be possible at the handheld controller.

B. The lift shall be capable of being stopped at any point between its extreme upper and lower limits by releasing the travel control button.
C. In no case shall the lift operate past its upper or lower limits.

D. Locate the lift control receptacles as per the drawings.
   1. Provide a finished rack-mount control receptacle panel in the Production Control Panel:
      a. Panel faceplate constructed of sheet metal, finished flat black.
      b. Labels to be engraved and white filled.
      c. Prewire the panel at the factory, insofar as possible.
      d. Provide terminal strips for field wiring terminations.
      e. Panel to contain the following controls:
         1) Emergency “STOP” latching mushroom-type pushbutton
         2) Multi-pin receptacle for handheld controller
   2. Provided a finished wall mount control receptacle station at the Orchestra Pit Level
      a. Station back box and faceplate constructed of sheet metal, finished flat black.
         Provide requisite mounting holes, conduit knockouts, etc.
      b. Labels to be engraved and white filled.
      c. Internally wired at the factory prior to shipping.
      d. Provide internal terminal strips for field wiring terminations.
      e. Station to contain the following controls:
         1) Emergency “STOP” latching mushroom-type pushbutton
         2) Multi-pin receptacle for handheld controller

E. The operation of the lifts to be as follows:
   1. The operator must plug the control pendant into the receptacle at the Production Control
      Panel or at Orchestra Pit Level. The appropriate direction pushbutton must then be pushed
      and held. The lift shall operate as long as the pushbutton is held or until it reaches the next
      predetermined stop (or upper or lower limit), whichever comes first. To continue operation,
      the pushbutton must be released and pushed again.

F. Motor Control Center (MCC):
   1. Provide Motor Control Center (MCC) in location as indicated in the drawings
   2. Provide MCC with current and thermal overload protection as required for components
      within.
   3. MCC cabinet must fit into the space provided and pass through the door provided. Field
      verify all site conditions.
   4. Provide motor drives by:
      a. Siemens
      b. Mitsubishi
      c. Or approved equal
   5. Logic systems to be solid state. Use of relays requires prior approval.
   6. Provide Emergency “STOP” latching mushroom-type pushbutton mounted on the face of
      the enclosure.
   7. MCC cabinet will be Areta modular cabinet system or approved equal.

G. Handheld Console
   1. Self-contained console that shall contain all requisite control processors with redundant
      elements necessary for complete operation.
      a. All necessary switches, back light pushbuttons, display screens, etc to perform all
         functions called for herein from this single console.
   2. Connection via a single control/power cable to the lift control receptacle.
      a. Provide 50’ of cable length
   3. Console shall include the following:
      a. A case made of impact resistant injection molded resin or equal.
      b. Independent Emergency Stop (as part of separate E-Stop system).
      c. Hold to run switch on console.
      d. Security access via PIN.
e. Menu selection keys.
f. Touchscreen panel display.
g. Emergency control in event of graphic failure.
h. Alarm signal of vital functions.
i. Auto selection and monitoring of line input power.
j. Auto fault detection of power supply inputs.

H. E-stop Enable Network
1. There shall be a low voltage VDC logic signal network called "e-stop-enable". This system shall run independently of the Lift Control System. Failure of the Lift Control System shall not disable this E-Stop network.
2. The e-stop enable network is continually active. In the event of an E-stop activation this network shall discontinue the operation of the Lift.
   a. Failure in this network shall cause the electronic motor control modules to cease operation. No motor element shall function unless the E-stop enable network is active.
   b. An individual E-stop device shall have dual /redundant contacts and have a high mean time before failure rate.

I. E-stop device
1. Provide wall mount e-stop device that shall have on the front an “E-Stop” mushroom push button which shall activate the E-Stop system.

2.6 SAFETY DEVICES

A. Removable Safety Railings
1. Provide steel tube frame railings to accept finished surface by others. Coordinate with General Contractor.
2. Each railing frame shall include two round locating pegs.
3. Railing frames shall be primed with rust inhibitor and painted with two coats of black enamel paint.
4. Provide sufficient tube steel rolling storage carts to store railings when not in use.
   a. Carts to be finished black

B. Safety Net
1. Provide a safety netting attached between underside of the upstage edge of the lift and the machine pit floor to create a visual indicator when the lift is not at Orchestra Pit level.
2. Provide sheet metal guards at machine pit floor to ensure safety netting does not interfere with lift columns when stored.
3. Provide full width, 1” diameter weight bar at 24” on center weaved through netting.
4. Provide ANSI compliant crush hazard warning sign at 48” on center along width of the netting.

C. Interlocks
1. Provide an interlock system utilizing proper placement or condition of railings, access doors, tape switches etc., as shown on the drawings. Lift shall be inoperative unless devices are properly activated.
   a. Design the system logic and provide triggering components (e.g. magnetic door locks, railing interlocks, etc.) under work of this Section.
2. Railing Interlocks
   a. Provide a reliable sensing system with railing detection devices for installation at the removable rail sections as shown on the drawings. When the integral circuits are activated, the detector shall indicate that the railing is in place and thereby deactivate restricted travel for the lift.
b. Audience Edge
   1) The audience edge interlocks shall restrict the lift from traveling below audience elevation unless the rail interlocks are detected.

c. Stage Side Edge
   1) The stage side edge interlock shall restrict the lift from traveling below audience elevation unless the rail interlocks are detected.

3. Door Interlocks
   a. Orchestra Pit
      1) Orchestra pit doors shall be locked when lift is not at Orchestra Pit level. A key override switch shall be provided at the entry to the orchestra pit for emergency access.
         a) Provide yellow mushroom-type momentary contact pushbutton for escape from the orchestra pit. The pushbutton will override door lock to allow exit from the orchestra pit.

   b. Trap Room
      1) The Trap Room door to the orchestra pit shall be locked when pit lift is not at Basement level. A key override switch shall be provided at the entry to the orchestra pit for emergency access.
         a) Provide yellow mushroom-type momentary contact pushbutton for escape from the orchestra pit. The pushbutton will override door lock to allow exit from the orchestra pit.

   c. Access Hatch
      1) The Machine Pit access hatch shall be locked when lift is in motion.

D. Shear Edge Protection
   1. Provide fail-safe pressure sensitive safety edges as required to protect against shear hazards in both directions of travel. Field verify and identify shear hazards.
   2. All overhanging surfaces and shear edges shall be equipped with a continuous pressure tape switch (astragal) fitted to a yield pad. Upon contact, the lift shall stop within the safe stopping dimension of the yield pad.

E. Motor controls will be sized to disengage or shunt at a value no greater than the capacity of the motor.

F. A visual flashing and audible “beeping” indicator, mounted on top of the Production Control Panel at Stage Level, will be activated whenever the lift is in motion.

G. Exposed rotary and transmission components must be guarded to prevent injury.

2.7 SOURCE QUALITY CONTROL

A. All equipment and components to be factory tested prior to shipping.

2.8 FABRICATION

A. Fabricate all work in this section in accordance with the Architect's direction, specifications, approved shop drawings, pertinent project drawings, established trade practices and applicable code requirements.

B. Machine finish all operating parts to standard trade tolerance, fits and finishes.
C. Carry out shop welding in full accordance with the appropriate sections of “Specification for the Design, Fabrication and Erection of Structural Steel for Buildings” of the American Institute of Steel Construction (AISC).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Contractor must examine areas and conditions under which the equipment is to be installed and must notify the General Contractor in writing of conditions detrimental to proper and timely completion of work. Work will not proceed until unsatisfactory conditions have been corrected in a manner acceptable to the Contractor.

3.2 INSTALLATION

A. Install all work in this section in accordance with the Architect's direction, specifications, approved shop drawings, pertinent project drawings, established trade practices and applicable code requirements.

B. Provide site supervision during the installation of electrical work associated with the Theatrical Lift system elements.

C. Install all work securely, complete with all bolts, nuts, washers, clips, fittings, supports, and other items required for proper installation and operation.

D. Position all items accurately as indicated on drawings and true to plumb, line and level. Maintain maximum headroom and clearances at all points.

E. Coordinate all work with all other trades to avoid causing delays in construction schedule.

F. All field welding requires prior approval of the Architect and Contractor's Structural Engineer.

G. Carry out approved field welding in full accordance with the appropriate sections of "Specifications for the Design, Fabrication and Erection of Structural Steel Buildings" of the American Institute of Steel Construction (AISC).

H. Do all cutting, drilling, tapping and approved welding required to properly install work. Obtain Architect's prior approval for cutting and drilling of existing structural work.

I. Clean structural steel and fabricated steelwork of rust, scale and foreign matter by grinding; prime with 1 coat of first quality primer; finish with 1 coat of first quality machinery enamel free of skips, runs and saps. Touch up all field connections, welds and abraded places with primer and enamel.

3.3 FIELD QUALITY CONTROL

A. The installation of the equipment indicated in this Section shall be supervised by qualified personnel who are regularly employed by the Contractor for supervision of equipment installation similar to that indicated herein.

B. Installers must be appropriately skilled and experienced for the type and quality of work.
C. Arrange for all tests and inspections required by the General Requirements.
   1. If any work is to be specially tested or approved, whether by the General Contractor's instructions or by any laws, ordinance or any public authority, the Contractor shall give the General Contractor and Architect timely notice of its readiness for inspections, and of dates of inspections to be made by appropriate authorities.

3.4 SYSTEM STARTUP AND COMMISSIONING

A. Commissioning
   1. Upon completion of installation work required by the work of this Section, the Contractor shall perform all required tests and inspections, including but not limited to the Compliance Testing Procedures specified herein.
   2. Contractor shall supply all equipment required for the commissioning process including access equipment (personnel lifts, ladders and appropriate protective equipment), test instruments and communications equipment.
   3. Contractor shall provide staff to assist in the commissioning process.
   4. Compliance Testing Procedures (CTP)
      a. Full load test at sustaining (static) and lifting (dynamic) capacity. Lifts to run under full dynamic load in up and down directions to all predetermined stops in each direction. Demonstrate all emergency stop circuitry under full load.
      b. Contractor to provide test weight, delivered, manipulated for testing, and removed from site. Provide floor protection during test.
      c. Provide means to momentarily bypass travel limits for testing/commissioning purposes. Temporary removal of the physical limit/actuator/striker shall not be acceptable.

3.5 ADJUSTING

A. Adjust all equipment and components for operation in accordance with the specifications, approved shop drawings and pertinent Contract Drawings prior to the demonstration indicated herein.

3.6 CLEANING

A. Touch-up minor abrasions and imperfections as required.

B. Remove from the premises all debris caused by this work. All unnecessary equipment and materials shall be removed from the area(s) of this work upon completion, removed from the job site and disposed of legally at no additional cost to the Owner.

3.7 CLOSEOUT ACTIVITIES

A. Demonstration
   1. Upon completion of Commissioning, the Contractor will notify the Theatre Consultant that the system is complete, conforms to specification and is ready for Demonstration.
   2. Installed equipment to be operated for approval and inspected for quality by the Theatre Consultant, the Architect and the Owner.
   3. Adjustments or modifications shall be made as directed by the Architect and the Theatre Consultant.
4. Costs of re-inspection and additional testing by the Architect and Theatre Consultant, if required, due to lack of completion and/or errors and omissions shall be paid by the Contractor. This work will be conducted on a time and materials basis, including the Architect's and Theatre Consultant's standard hourly rates, and shall be scheduled and approved in writing prior to the re-inspection/testing session.

B. Training
1. Following the equipment demonstration, inspection and final adjustments, provide an instruction session to the Owner’s staff or representatives on the safe operation, care and maintenance of all items.
   a. Instruction shall include, but not be limited to, proper general maintenance of the system, replacement procedures for user replaceable parts, and operating procedure to obtain maximum usage of system.
   b. Provide one (1) half-day of staff training on operation of motor drive elements. This shall include basic safety in the use of the system as well as the handling of mechanical elements. Attendance shall be limited to ten (10) personnel.
   c. Deliver all copies of approved Operations Manual to Owner prior to first instruction session, and review it as part of that session.
2. Timing for all sessions shall be scheduled by the Owner at their convenience.
3. All training shall be by technical staff of the Contractor.

3.8 PROTECTION
A. Provide full protection from damage, construction dirt and debris for all equipment from the point of installation to testing and commissioning.
B. Remove all equipment protection and clean all components thoroughly prior to the demonstration session.

3.9 MAINTENANCE
A. Maintenance Services:
   1. One month prior to the end of the first year following the date of final systems acceptance, a factory engineer shall be provided to examine, adjust and repair the equipment included in this section as required. This service shall not cover adjustments, repairs or replacement of parts due to negligence, misuse, abuse or accidents caused by persons other than the Contractor. All labor and materials which are required to perform this service shall meet or exceed these specifications and shall not compromise the performance of the equipment in any way.
   2. Following this inspection and maintenance service, the Contractor shall provide the Owner and Theatre Consultant with a written report itemizing the results of the inspections and the warranty work that was conducted. The Contractor shall also include in this written report recommendations for any corrective actions which the Contractor feels should be taken with respect to the equipment included in this section but are outside the scope of the warranty agreement.
      a. The report of the one year inspection shall be furnished within fifteen days of the inspection. It shall indicate the findings, recommendations, revised maintenance procedures, etc.
B. System Programming Updates
   1. Contractor shall review system operation and control system programming with the Owner's representatives. Any required adjustments and changes to the control system programming requested by the Owner shall be performed and completed during the time
of the corrective service site visit. All control system programming changes shall be
documented by the Contractor.

C. Maintenance Contract
   1. Provide to the Owner an executed yearly maintenance agreement for a total of 5 years.
      This agreement must include, but not be limited to:
         a. Visual inspection of each lift system and all associated hardware.
         b. Upgrade, if available, to the latest release of the software compatible with the
            existing control system.
         c. Network data distribution inspection.
         d. Re-training of existing personnel and new training of new personnel. This training
            is to be at the same level or better than the original training.
         e. All material, components, accessories and services required to provide the work as
            specified herein.

END OF SECTION 11 61 35
## Theatrical Lighting Dimming and Control

<table>
<thead>
<tr>
<th>ITEM #</th>
<th>ITEM DESCRIPTION</th>
<th>MANUFACTURER / PRODUCT</th>
<th>PROSCENIUM THEATRE</th>
<th>BLACK BOX THEATRE</th>
<th>VALADE CENTER (BASE BD)</th>
<th>VALADE CENTER (ALTERNATE #8)</th>
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**Note:**

This equipment list specifies major systems components and equipment, and should not be interpreted as a "bill of materials". This list may not detail all equipment required for complete, working systems. It is the Lighting Systems Contractor's responsibility to provide complete, working systems regardless of the completeness of this list.
<table>
<thead>
<tr>
<th>ITEM #</th>
<th>ITEM DESCRIPTION</th>
<th>MANUFACTURER / PRODUCT</th>
</tr>
</thead>
</table>

END OF SECTION 116163 - APPENDIX A
SECTION 116163
THEATRICAL LIGHTING DIMMING & CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. The work in this section includes Theatrical Lighting (TL) systems and equipment within the following spaces and associated support areas:
   1. Proscenium Theatre
   2. Black Box Theatre
   3. Valade Jazz Center

B. Section Includes
   1. Major Systems and Equipment: furnish and supervise installation of the following major elements and associated accessories:
      a. Theatrical and Architectural dimmer racks
      b. Theatrical and Architectural DMX controlled panelboards
      c. Auxiliary equipment/electronics racks
      d. Lighting systems computers
      e. Theatrical lighting Ethernet data networks
         1) Network racks
         2) Network components
         3) Network devices
         4) Network receptacles
         5) Wireless network
      f. Lighting systems computers
      g. Architectural lighting control systems
         1) Architectural control processors
         2) House panic systems
         3) Architectural lighting emergency bypass devices
         4) Architectural control panels and receptacles
         5) Portable house light master station and receptacles
      h. Theatrical lighting wiring devices
      i. All elements shown on “TL” Series drawings

2. Work Results:
   a. Provide all hardware and software required for a complete and working theatrical lighting system as described herein.
   b. Provide fully coordinated and engineered equipment, installation, supervision and commissioning for the following major systems and associated accessories as required for each space.
   c. Provide supervision of Theatrical Lighting Systems low voltage signal cable pulling, termination and testing by the Division 26 Electrical Contractor.
   d. Provide coordination of conduit, backboxes and AC power wiring provided by the Division 26 Electrical Contractor.
   e. Provide coordination of digital fixture addressing for factor-configured architectural lighting fixtures/drivers provided by the Division 26 Electrical Contractor.
   f. Provide factor-trained technician on site to address all digital architectural lighting fixtures/drivers, configure system nodes and electronics, and assist the architectural lighting designer in programming architectural lighting presets.
g. Provide all material, components, accessories and services required to provide the work as specified herein, elsewhere in the project documents and/or as shown on related drawings.

h. Consult and coordinate with other affected work and contractors throughout the course of the work contained herein.

C. Products Supplied But Not Installed Under This Section
   1. All equipment shall be installed and terminated under Division 26, except as noted below in paragraph D.1.

D. Products Installed But Not Supplied Under this Section
   1. The work of this section includes supervision of the termination of all control wiring in panels and racks. All control cabling related to this section shall be installed under Division 26.

E. Related Requirements
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications apply to this Section.
   2. Examine Contract Documents for requirements that directly affect or are affected by work of this Section. A list of those Documents and Sections includes, but is not limited to the following:
      a. Division 01 – General Requirements
      b. Division 03 – Concrete
      c. Division 04 – Masonry
      d. Division 05 – Metals
      e. Division 09 – Finishes
      f. Division 11 – Equipment
         1) Section 116133 – Theatrical Rigging
         2) Section 116173 – Theatrical Lighting Instruments and Accessories
      g. Division 12 – Furnishings
         1) Section 126100 – Fixed Audience Seating
      h. Division 21 – Fire Suppression
      i. Division 22 – Plumbing
      j. Division 23 – Heating, Ventilating and Air Conditioning
      k. Division 26 – Electrical
         1) Section 265100 – Architectural Lighting Fixtures
         2) Section 265561 – Theatrical Systems Electrical Requirements
         3) General requirements for all Electrical work, including installation of system cable trays, terminal cabinets, empty conduit, junction/pull boxes and back boxes for system devices and panels (Division 26).
         4) Electrical terminations (AC power and grounding only) to all equipment racks and AC power receptacles (Division 26).
         5) Provision and installation of all conduit and back boxes (Division 26)
         6) Electrical services and main circuit protection (Division 26)
         7) Distribution system equipment (Division 26)
         8) Conduit, wire, pull boxes, junction boxes and miscellaneous hardware and components as required for a complete electrical installation.
         9) Terminations and testing of system continuity
      l. Division 27 – Communications
         1) Section 274100 – Performance AV Systems
         2) Structured cabling systems
         3) At common facility panels, coordinate receptacles for building standard communications systems.
1.2 PRICE AND PAYMENT PROCEDURES

A. Refer to Division 01 - General Requirements for information regarding price and payment procedures.

B. Unit Prices
   1. Provide Unit Price for items described in paragraph 1.7.A.2.

C. Alternates
   1. Provide separate price information for material and labor associated with the following equipment and systems:
      a. Alternate #4 – Multi-pin receptacles at catwalk plugging strips (Proscenium Theatre)
   2. Provide separate price information to deduct the material and labor associated with the following equipment and systems from the price of the full and complete systems as otherwise specified in this document:
      a. Alternate #8 - Device Type ‘ET3’ and associated network infrastructure (Valade Jazz Center)

1.3 REFERENCES

A. Abbreviations:
   1. The following abbreviations and acronyms are relevant to this Section and are in addition to those defined in Division 01 – General Requirements:
      a. DMX or DMX 512: ANSI E1.11 - 2008, USITT DMX512-A
      b. NFPA: National Fire Protection Association
      c. NEC: National Electric Code
      d. UL: Underwriters Laboratories
      e. IEEE: Institute of Electronic and Electrical Engineers
      f. IESNA: Illuminating Engineering Society of North America
      g. ANSI: American National Standards Institute
      h. AISC: American Institute of Steel Construction
      i. NEMA: National Electrical Manufacturers Association
      j. TIA/EIA: Electronic Industries Alliance/Telecommunications Industry Association

B. Definitions
   1. The following definitions are relevant to this Section and are in addition to those defined in Division 01 – General Requirements:
      a. In all cases where a device or a part of equipment is referred to in a singular manner within the contract documents, it is intended that such a reference shall include all devices required to complete the installation in accordance with the project documents.
      b. “Architect”: All references to the “Architect”, Hamilton Anderson Associates, will refer to the process by which the indicated action or decision regarding the work in this section will be administered. All such actions shall be initiated with or by the Architect, who will disseminate all pertinent information and documents to, as well as coordinate all efforts and site visits with, the Theater Consultant and all other project consultants who may have design responsibility relating to the work in this section.
      c. “Theater Consultant”: Auerbach + Associates, Inc. (d.b.a. Auerbach Pollock Friedlander). The Theater Consultant will be party to all actions and decisions regarding the work in this section.
      d. “Other Project Consultants”: Acoustical Consultant, Electrical Engineer, Structural Engineer, or Mechanical Engineer as is applicable to a particular issue.
e. “Contractor”: Manufacturer / Installer responsible for the fabrication and installation of the work contained in this section.
   1) Contractors involved with other work shall be indicated with a specific trade preceding the word “Contractor” (i.e. General, Electrical, etc.).

f. “Owner”: Authorized personnel representing Wayne State University.

g. “Furnish”: Purchase and/or fabricate and deliver to project site.

h. “Install”: Physically install the items in their proper location (s) on the project site.

i. “Provide”: Furnish and install.

C. Reference Standards:
1. Reference Division 01 for general project references and standards.
2. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies will refer to the latest edition of such publications adopted and published prior to submittal of the bid. All such codes and standards will be considered a part of this specification as if they were fully included herein.
3. If an applicable code or standard permits work of lesser quality or extent than this specification, then this specification and the related drawings will govern.
4. Comply with national, state and local codes.
5. Comply with national, state and local labor regulations and requirements.
6. The following standards apply to the work of this Section. It remains the Contractor’s responsibility to confirm and comply with all industry standards that are applicable to the work of this Section.
   a. Underwriters Laboratories
      1) UL 924
      2) UL 1008
   b. Institute of Electronic and Electrical Engineers
      1) IEEE 802.3ab
      2) IEEE 802.3af
      3) IEEE 802.3at
      4) IEEE 802.3z
   c. Illuminating Engineering Society of North America
   d. American National Standards Institute
      1) ANSI E1.11 - 2008, USITT DMX512-A
      2) ANSI E1.17-2010, Architecture for Control Networks
      3) ANSI E1.20, Remote Device Management over DMX512 Networks
   e. Electronic Industries Alliance/Telecommunications Industry Association
      1) ANSI/TIA/EIA 568-A
      2) Category 5e Standard
      3) ANSI/TIA/EIA-568-B
      4) Category 6 Standard
   f. American Institute of Steel Construction
      1) Specifications for the Design, Fabrication and Erection of Structural Steel Buildings
   g. National Electrical Manufacturers Association

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. The Contractor is required through drawings, memos and meetings to properly coordinate the work with the other sections as necessary to complete the work of this section.

B. Pre-installation Meeting:
1. Refer to Division 01 - General Requirements for information regarding pre-installation meeting with the General Contractor.
C. Sequencing:
   1. The installation of the equipment in this section shall be coordinated with other work which may be in conflict with or which must be completed before the work under this section may be installed, including:
      a. Principal foundation work (see Architectural Drawings)
      b. Installation of associated electrical work (see Electrical Drawings)
      c. Installation of HVAC work in ceilings (see Mechanical Drawings)
      d. The installation of the electromechanical systems equipment, panels and devices shall not occur until all painting in the area has been completed.
      e. Electromechanical and electronic equipment installation shall proceed after environmental site conditions are met. Refer to paragraph 1.10-B for class requirements.

1.5 ACTION SUBMITTALS

   A. All submittals shall be submitted in accordance with Division 01.

   B. All submittals shall be submitted in a timely manner, allowing sufficient time for adequate review and possible resubmittals without jeopardizing project schedule.

   C. Submittals will be reviewed, accepted and field dimension verified prior to proceeding with the fabrication of the work in this section.

   D. All submittals shall leave space available for review stamps and comments.

   E. The Architect and Theatre Consultant shall only mark one set of drawings per submittal with comments. Any additional sets of drawings or product data shall be returned unmarked.

   F. Provide insurance against loss or damage during shipment. Furnish certifications of such coverage to the General Contractor not less than 60 calendar days prior to the shipment of any equipment.

   G. Review all pertinent project Contract Documents. Following this review, provide to the Architect and General Contractor any additional information required to make a fully functioning system. In addition, the Manufacturer shall indicate the maximum accepted wire size as it relates to termination points on their equipment.

   H. Verify wire type, count and routing for all required data wiring between all components to allow for proper conduit sizing and routing by Division 26. Verify and coordinate all line voltage power input required by systems components that shall be provided under Division 26.

   I. Product Data:
      1. Where standard manufacturer parts are used, submit current product literature describing component, manufacturer's recommended applications, load ratings, safety factors and dimensions. The data shall include all information which indicates compliance with the specifications herein.
      2. Clearly indicate specific component and applicable options.

   J. Shop Drawings
      1. Provide shop drawings on D size minimum (24” x 36”) sheets.
      2. Include a cover sheet with a drawing index including the sheet number and title for each sheet in the set.
3. Provide complete, fully dimensioned, large-scale detailed drawings of all major components.
4. Provide requisite schematics, plans and sections indicating assembly and installation of components.
5. Provide indications by arrow and boxed caption of all variations from contract drawings and specifications, except where variation is indicated as acceptable.
6. Provide detailed one-line riser diagrams and installation circuit diagrams indicating all control and/or data electrical requirements and point to point connections. These shall be provided within 30 days of Contract Award.
7. Provide touchscreen layouts and functional narrative for review four weeks prior to final system checkouts.
8. Provide a full Bill of Materials to be supplied, including quantities, manufacturers, manufacturer's part numbers, reference to applicable drawings, etc.

K. Samples
1. Submit sample items including, but not limited to:
   a. Panel engraving or silk screen
   b. Distribution device engraved lamacoid label showing attachment method.
2. Additional samples must be submitted within 14 days of Architect's written request.

L. Source Quality Control Submittals
1. The Contractor shall supply as part of the submittal process the following Source Quality Control documents:
   a. Serial number of equipment tested
   b. Serial number of any component device(s)
   c. Batch number of major components
   d. Name of person conducting the test
   e. Date the test was conducted
   f. List of mechanical tests conducted
   g. List of electrical tests conducted

M. Special Procedure Submittals
1. Training
   a. To ensure proper training of the user group, the Contractor shall supply as part of the submittal process the following training documentation:
      1) Training syllabus
      2) Training guide (bound hard copy)
      3) Training guide (hands on system training)
      4) Testing document for confirmation of understanding
      5) DVD/ MPG video training file
   b. These shall be provided two (2) months prior to completion.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents:
1. Submit documents in accordance with Division 01 – General Requirements.
2. At the time of acceptance testing, submit three (3) copies of parts lists and maintenance instruction sheets.
3. Within 60 days of the acceptance testing, submit one (1) set of reproducible "as built and approved" drawing showing all equipment as installed. These drawings shall include all adjustments made during the checkout process.
4. Submit operation and maintenance manuals with the “as built and approved” drawings. Each manual shall be bound in an individual binder with the project name on the front cover and system identification on the spine. The manuals shall include:
a. Complete parts list for all equipment and telephone numbers for the authorized parts and service distributors.
b. Instructions as to the safe operation for all equipment.
c. Recommended maintenance schedule for component parts that may need periodic replacement or maintenance.
d. Recommendations for cleaning, maintaining and touch-up of all finished surfaces.

5. Where specific elements do not require manuals, instruction sheets as to care and handling shall be provided.

6. Warranties as required herein.

B. Maintenance Contract
1. Refer to 3.10 – Maintenance.
2. Submit maintenance contract proposal for Owner and Theatre Consultant review no later one month prior to substantial completion.

C. Submit verification that all punch list items have been rectified. Such written verification will be required for project closeout and initiation of the warranty period.

D. The record documents shall be reviewed by the Architect and all modifications to the documents stemming from this review shall be made as required.

E. Above submissions are required as a condition for final approval of the work.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:
1. Furnish a package of spare parts for all user serviceable portions of the theatrical lighting system equipment:
   a. Furnish 10% of total quantity of each type of small component or part in system as spare parts (minimum of one). Package may include connectors, bulbs, fuses, knobs, switches, and other miscellaneous parts, in addition to any spare parts specifically listed in individual product specifications.
   b. Label all spare parts with Manufacturer’s part number, designation and description, and location(s) where used.
   c. Furnish durable, clearly labeled, storage containers for all spare parts, including special static free containers for electronically sensitive parts.
   d. Furnish five (5) 16GB USB flash drives or other appropriate data storage medium.
2. Provide unit price for recommended package of parts.

B. Extra Stock Materials:
1. Deliver stock of maintenance material to Owner. Furnish the following to match those installed and taken from the same production run, packaged with protective covering for storage and identified with appropriate labels:
   a. Furnish spare dimmer modules (minimum of two, or in quantities as listed in the Appendix) for each type of installed dimmer module in the system.
   b. Furnish one spare node or complete internal components of each type of installed node in the system.
   c. Furnish 5% circuit breakers (minimum of one) of each size in the system, including automated circuit breakers.

1.8 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Refer to Division 01 – General Requirements.

B. Qualifications:
1. Manufacturers
   a. The Manufacturer shall own and operate their own manufacturing facility for the fabrication of theatrical lighting dimming and control equipment, and be regularly engaged in the fabrication of such equipment. Fabrication of such equipment shall comprise no less than 90% of the Manufacturer’s business.

2. Installers / Integrators
   a. The systems and equipment under this Section shall be provided through a single pre-approved Contractor who is a factory authorized dealer, integrator and servicer of all of the equipment specified herein and meets the following requirements.
   b. The Contractor shall maintain a full-time Manufacturer-trained and certified field engineering staff of at least two people available within 4 hours travel of the project location on an emergency basis. Staff shall be employed by the local authorized dealer and trained in electronic lighting control systems and Ethernet systems services.
   c. The Contractor shall have been continuously engaged in the integration and installation of theatrical lighting equipment for no less than five years and shall have provided complete engineering and installation services on a minimum of five projects of similar scope and complexity in the past five years.
   d. Project Manager: The Contractor’s Project Manager shall be qualified and have experience in projects of similar size and scope. The Project Manager shall have binding authority to represent and act for the Contractor and Manufacturer of this equipment. The Project Manager shall be the primary conduit for all information between the supplier of this equipment and the General Contractor. All information given to the Project Manager shall be considered as given to the Contractor.
   e. The Contractor shall have, at the time of bid, a current contractor’s license and shall know, understand, and have the required documentation to work in the State of Michigan. This license shall be maintained throughout the course of the work of this contract.
   f. Contractor is responsible for proper installation, operation and safety of all component equipment.
   g. Contractor is responsible for the complete integration and engineering of all systems described herein. Contractor shall confirm project details and, if necessary, suggest modifications to the criteria established herein in order to maintain the design intent.
   h. Errors and omissions within the Contract Documents shall not relieve the Contractor and the General Contractor of the responsibility for providing a properly functioning installation of the system as described herein.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage and handling shall be coordinated with the General Contractor and shall meet all requirements described in Division 01.

B. Packing, Shipping, Handling and Unloading
1. All equipment shall be appropriately and substantially packed for shipment.
2. All equipment containers shall clearly indicate the equipment contained, “front”, “top”, “fragile”, the project name, and theater site allocation. Include packing and shipping lists for each container.
3. All shipping costs to the job site are the responsibility of the Contractor. The shipping method/company is at the total discretion of the Contractor in order to meet the published project schedules.
C. Acceptance at Site
   1. Coordinate responsibility for acceptance of material and equipment at job site with the General Contractor.
   2. The Contractor shall be responsible for acceptance of the Theatrical Lighting System components at the job site, confirming that all quantities and counts are correct and for keeping accurate logs and records of such information.

D. Storage and Protection
   1. Upon delivery, the materials shall be stored under cover in a clean and dry location, off the ground. Delivered materials which are damaged or otherwise not suitable for installation shall be removed from the job site and replaced with acceptable materials.
   2. Replace, at no additional expense to the Owner, all equipment and materials which are damaged during storage or handling.

1.10 SITE CONDITIONS

A. Existing Conditions
   1. Verify all conditions at job site. Promptly report variations and obstructions to the Architect. All additions and/or corrections are to be requested prior to fabrication.

B. Environmental Requirements
   1. Equipment is classified according to its susceptibility to construction conditions that may affect its operation. Classes shall be defined by the following paragraphs:
      a. Class 1:
         1) Cable and distribution apparatus, structural elements, electrical back boxes, face plates, terminal boxes, and empty equipment rack frames may be stored in weather protected spaces under "normal" construction site conditions provided that no electronic components are contained within devices, storage boxes are sturdy and well-sealed, and equipment is protected with imperforate inner plastic sheeting.
         2) Contractor may install this class of equipment in weather-protected spaces under "normal" construction site conditions provided that equipment is protected from dust and moisture by sturdy imperforate plastic sheeting and completely covered with corrugated cardboard held securely in place by duct tape. Cardboard covers shall not be removed until area is broom cleaned. Under no circumstances shall equipment remain uncovered overnight during installation or while work which causes high dust or moisture levels in area of placement is taking place.
      b. Class 2:
         1) Control panels, spare parts, test and other equipment (except as listed under Class 3) not subject to damage by concrete dust or dirt shall be stored and protected per Class 1 devices.
         2) Contractor shall not install equipment in this class until area of installation is broom cleaned, "blown" clean with pressurized air, mopped, air conditioned and secure. Contractor may install control panels with electronic components under Class 1 conditions, but electronic components must be removed and not installed until area of installation meets Class 2 conditions.
      c. Class 3:
         1) Control consoles, filled equipment racks and other electronic equipment shall not be shipped to site until the rack and control rooms are finished, air conditioned, dust free, broom and mop cleaned, secure, and in all respects complete and ready for occupation.
         2) This class of equipment shall not be unpacked until the system is complete in all other respects. Under no circumstances may any equipment in this class be opened before the entire system is complete and ready for occupation.
be removed from the rack and control rooms into or through spaces which are not cleaned, air conditioned, and complete.

C. Field Measurements
   1. Field measurements must be taken prior to preparation of final shop drawings and prior to fabrication to ensure proper fitting of work. Allow for adjustments during installation whenever taking field measurements.
   2. Should field measurement of site conditions alter the design or installation of system elements from the approved shop drawings, revised shop drawings shall be reissued for review.

1.11 WARRANTY
A. Comply with the warranty requirements of Division 01 and the following.
B. The Manufacturer shall warrant materials and workmanship of systems and equipment installed as free of defects. The Manufacturer shall guarantee in writing the repair or replacement within 14 days of any item found defective during a period of two (2) years following date of final acceptance. Ordinary wear and defects due to improper usage are excepted.
C. The Contractor shall warrant the workmanship of the installation services provided under this Section for a period of two (2) years following the date of final acceptance. Ordinary wear and damage due to improper usage are excepted.
D. During the warranty period, all emergency conditions where systems failures may be hazardous or may cause severe hardship or cancellation of performances shall be responded to within 24 hours. Immediate action shall be undertaken to ensure the safety of the audience and the performers.
E. During the Warranty Period, for each product that uses software, furnish manufacturer’s software updates to the Owner for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. To establish comparative standards of quality the systems and equipment described herein shall be furnished by the manufacturers listed herein and in the Appendix.
   1. Manufacturers shall provide the Warranty and Maintenance services specified herein as applicable to their products.
   2. Manufacturers shall engineer, design, produce shop drawings and fabricate all custom equipment required in this section.

2.2 SYSTEMS DESCRIPTION

A. The following performance spaces shall contain the following major system components listed below and as shown on the TL-series drawings:
   1. Proscenium Theatre
      a. Theatrical Dimmer Racks and Modules
         1) Installed dimmer racks with 500ms rise-time flexible configuration dimmers
2) Paralleled branch circuits to some quantity of dimmers (ref. schedule)
3) Air flow modules in place of dimmer modules for some quantity of dimmer racks (ref. schedule)

b. DMX controlled panelboards
   1) 120V 20A single pole circuit breakers feeding receptacles for 120V lighting fixtures, including LED source fixtures with on-board dimming.
   2) 120V 20A single pole circuit breakers feeding branch circuits for 120V architectural lighting fixtures.

c. Network data system
d. Network connection devices
e. Architectural lighting control system
   1) DMX bypass for LED source house lighting
f. Architectural lighting control panels
g. Dimmed and switched power distribution devices
   1) Plugging strips
   2) Plugging boxes

2. Black Box Theatre
   a. DMX controlled panelboards
      1) 120V 20A single pole circuit breakers feeding receptacles for 120V lighting fixtures, including LED source fixtures with on-board dimming.
      2) 120V 20A single pole circuit breakers feeding branch circuits for 120V architectural lighting fixtures.

   b. Network data system
c. Network connection devices
d. Architectural lighting control system
   1) DMX bypass for LED source house lighting
e. Architectural lighting control panels
f. Switched power distribution devices
   1) Plugging strips
   2) Plugging boxes

3. Valade Jazz Center
   a. Architectural Dimmer Modules
      1) Electronic low voltage dimmer modules for line voltage dimming of new architectural lighting fixtures, for use in existing theatrical dimmer racks.

   b. DMX controlled relay panels
      1) 120V 20A single pole relays feeding branch circuits for 120V architectural lighting fixtures.

c. Network data system
d. Network connection devices
e. Architectural lighting control interfaces
   1) DMX control interfaces to support low voltage dimming of architectural lighting fixtures, for use with existing architectural control processor.

f. Architectural lighting control panels

B. The systems shall be professional theatrical lighting systems complete with all necessary accessories to provide control, dimming and switching of incandescent and LED theatrical lighting fixtures via a wired and wireless network of power and data distributed through each space included in the work of this section.

C. The system in each space shall be complete and operate independently allowing concurrent use without dependence on the equipment or components in other spaces. Each performance space’s data network system shall allow for a temporary connection to the main building network for communication with equipment manufacturers’ firmware updates.
D. The control system in each space shall be ACN, RDM and DMX compatible, operating over a TCP/IP network using CAT 5e cabling.
   1. Data shall be provided via theatrical lighting consoles, architectural lighting processors and control panels, and wired and wireless remote devices. Data shall be input to the network via direct network connection or via DMX input nodes.
      a. All input devices shall exist as network devices with distinct IP addresses capable of addressing any endpoint device on the network based on the properties defined by the master console.
   2. Data shall be distributed over the Ethernet network to installed DMX nodes or to network taps for use with portable DMX nodes. Data shall be converted to DMX at the nodes for use by endpoint devices.
   3. The system shall provide PoE via endspan network switches compatible with the specified DMX nodes.

E. State of the Art Development
   1. The Contractor shall furnish only the manufacturers' latest developed appropriate products. In cases where product development from a specified manufacturer surpasses the criteria of this specification, the Contractor shall inform the Architect and make the newer product available to the Owner for acceptance. In no case shall discontinued or obsolete equipment be acceptable. Should a newer product be suggested as a substitution for a discontinued product, or for a product that is in process of being phased out of production, that newer product shall be offered to the Owner at no additional cost.
   2. Should product recall by the Manufacturer require temporary or permanent replacement of a product specified under this section, the Contractor shall notify the Owner at the earliest reasonable time and shall arrange to replace the product in question at the earliest possible time.
   3. Equipment found defective or subject to recall prior to scheduled installation shall not be delivered to the job site.
   4. Equipment defect or intended recall shall not relieve the Contractor from his contractual obligation with regard to delivery schedule of product. In this circumstance, notification shall be made to the Architect by express carrier. Arrangement for alternate product shall be made at this time.
   5. Under no circumstances shall arrangement for alternate product necessarily require the Owner to accept superseded equipment except on a temporary basis.

F. Substitutions
   1. All requests for variations from the specified materials and products will be reviewed by the Architect according to the procedures outlined in Division 01.
   2. All requests for substitutions must be submitted in a timely manner, so as not to adversely impact the project schedule.
   3. Substitutions will only be accepted if, in the opinion of the Architect, the product is an equal to the specified product. No substitutions may be made without written acceptance from the Architect. All substitutions made prior to this acceptance are at the sole risk of the Contractor.
   4. A substitution must be a product of equal design, construction and performance. The Contractor must submit all pertinent information required to substantiate that the product is equal. The Contractor must submit all additional information, including test data, which may be requested in order for the Architect to fully evaluate the substitution. The burden of proof is solely on the Contractor.
   5. All additional expenses of any kind with respect to substitution(s) shall be borne by the Contractor. This shall include, but not be limited to, all fees and expenses incurred by the Architect and other related Consultants for evaluation of the substitution and subsequent integration into the project should the substitution be taken and/or additional costs of other contractors related to the substitution(s).
2.3 MATERIALS

A. General

1. All equipment and components shall be new and complete. No used or reconditioned equipment shall be acceptable.
2. All mounting hardware shall be included.
   a. All bolts and fasteners required to mount equipment to mounting hardware must be Grade 5 or better.
3. All equipment and components shall be factory tested prior to shipping.
4. All bolted attachments shall have lock washers or other approved self-locking hardware.
5. All internal wiring shall be factory completed and clearly marked. All field connections shall be by connector, terminal strip or other device specified herein. Any terminal strip connections shall be clearly labeled as to terminal designation.
6. All wire sizes and insulation shall comply with NEC, NFPA and UL standards and all other applicable national and local codes.
7. All wiring to be harnessed and bound. No loose or randomly routed wires shall be permitted.
8. All control wire counts shall include 10% spares.
9. All microprocessor controls shall utilize a non-volatile memory. System configuration, operating parameter, preset, etc. shall be protected against system power failure for a minimum of 48 hours.
10. Systems components shall be modular in nature. Individual dimming modules shall slide in and be easily disconnected from power and removed from the rack without disturbing adjacent components and shall require no special tools for these tasks. Control circuitry shall be contained on plug-in printed circuit cards. Plug-in circuit cards shall be individually removable without disturbing adjacent components.
11. All fixed components including dimmer modules, non-dim modules, circuit breakers, and cabinets shall be labeled sequentially for ease of maintenance.
12. No manufacturer’s logo shall appear on control station faceplates or any other device located in public areas.
13. Any supplementary or auxiliary equipment necessary for the operation of the system shall be supplied with overload and short-circuit protection.

2.4 DIMMER RACKS AND MODULES

A. Dimmer Equipment Racks:

1. The entire dimmer rack assembly shall be UL listed. Rack finishes shall be manufacturer’s standard baked enamel color.
2. Dimmer racks shall be floor mounted, dead front switch boards complete with all dimmers, control electronics, timers, circuit breakers, and wiring terminations. No external components shall be required.
3. Dimmer slots shall be sequentially numbered and labeled on both sides of the dimmer slots.
4. Each dimmer rack shall be labeled as indicated on the drawings or as listed in dimmer schedules. Engrave and fill or silk-screen labels.
5. Dimmer racks shall be completely wired internally by the Manufacturer. The Electrical Contractor shall provide input feed wiring, load wiring, low voltage wire pulls and individual cabinet disconnects. All terminals shall be clearly and permanently marked and numbered.
6. Dimmer racks shall be constructed of #14 or #16 US gauge cold rolled sheet steel.
7. Provide access panels or knockouts for bottom feed and top load/control wires.
8. All internal components shall be accessible from the front for testing and adjusting while system is operating. No rear access shall be needed for installation or future service.
9. Power distribution shall be by copper buss bars. Aluminum buss bars are not acceptable.
10. Theatrical and Architectural dimmer racks shall be 120/208 volt, 3 phase, 4 wire, size for minimum 600-amp feeds, as indicated on Division 26 contract documents.

11. Theatrical and Architectural dimmer rack load, neutral and ground terminals shall accept up to #2 AWG wire.

12. Individual rack disconnects shall be provided under Division 26. Coordinate fault current requirements with the Architect.

13. All internal wiring shall terminate in pressure wire or clamp type terminals for installation of Electrical Contractor’s wiring. No wire nuts or crimps shall be acceptable.

14. All wiring provided by the Electrical Contractor under Division 26 shall be individually labeled at both ends of wire and at all splice locations.

15. Each branch load circuit must have an individual neutral to the dimmer cabinet terminals. Common neutrals shall not be acceptable for any load wire from the load to the dimmer cabinet terminals. Clearly note this requirement on all documentation. Reduced sizes are acceptable with prior approval of Architect.

16. Standard advertised product dimensions are to be considered maximum and are not to be increased. Dimensions acceptable with prior approval of Architect.

17. Location of dimmer racks shall be as shown on drawings. Provide quantities of cabinets dictated by dimmer quantity indicated herein.

18. Provide requisite ancillary, current modifying, regulating, and monitoring devices required for operation of a complete fully functioning system.

19. Dimming panels may be cooled by free convection without the use of cooling fans or by fans or blowers with screened air inlet and outlet grilles. Regardless of cooling method, dimming panels shall operate within a maintained ambient room temperature range of no less than 32°F and no more than 95°F degrees.

20. Provide cabinet overheat sensor and pilot light for each cabinet mounted in face of cabinet. Automatic shut off of the dimming system components shall occur should maximum safe operating temperatures of the cabinet be exceeded. Over heat sensor shall be duplicated to provide remote warning messages located on the theatrical lighting control console.

21. The interior construction of the entire electrical assembly shall be designed for a minimum standard fault current of 50,000 AIC with the capability for increased protection to 100,000 AIC, if required.

22. Noise generated shall not exceed 55db per cabinet, as measured with a Type 2 sound level meter at a distance of three feet from the cabinet in installed dimmer location.

23. The racks shall be mounted on vibration isolation mounts or pads consisting of a neoprene core with steel bearing plate, and a neoprene friction surface. Isolation mounts shall be Mason Industries Type “ND” or as specified by the project Acoustician; isolation pads shall be Mason Industries Type “WMSW” or as specified by the project Acoustician.

24. Dimmer bank shall accept USITT standard DMX512-A protocol digital control signal or Category 5e or greater Ethernet control signal in addition to any proprietary protocol control signal supported by the Manufacturer. Ethernet dimmer rack shall provide two (2) data inputs functioning on a Highest Takes Precedence basis.

25. Selection of signal protocol shall be automatic and shall not require use of mechanical transfer relays.

26. Control signal input of each individual dimmer rack shall be fully opto-isolated from control signal input of any other rack, and fully opto-isolated from any control signal output.

B. Dimmer Modules:

1. Dimmers shall meet all dimming performance criteria as listed in this section.

2. Dimmer electronics shall be completely solid state. Silicon controlled rectifiers shall be used to control AC power supplied to the loads.

3. Dimmers shall utilize two silicon-controlled rectifiers in back-to-back electrical configuration and all required gating circuitry on high voltage side of an integral opto-coupled control voltage isolator.

4. Rectifiers shall be mounted on ceramic substrate and encapsulated along with other components in epoxy-filled high-impact plastic case.
5. All dimmer modules shall be able to operate as “non-dims” with selection of this function through dimmer rack and control console software.
   a. When selected as a “non-dim”, incoming control signal level is interpreted as either full on or full off signal.
   b. Level of control signal required to initiate turn-on and turn-off shall be user selectable from 0% to 100%.
   c. Non-dim function shall operate regardless of load type or wattage.

6. Dimmers shall operate properly on 60 Hz, 120 - 140 volts AC input. Dimmer output shall be AC, containing less than 1% DC component. At maximum input signal, the dimmer shall produce a full sine wave. With the input signal at zero, the dimmer output shall be zero voltage at any load with regulation set OFF. Output shall be symmetrical to the zero voltage axis at any control setting prior to any electronic enhancement.

7. Dimmer efficiency shall be at least 97% at any voltage and with any load to maximum capacity.

8. AC voltage control components shall be rated at a minimum of two times the rated capacity of the dimmer and shall sustain a total short circuit for a sufficient length of time to open primary circuit protection.

9. Incandescent dimmers (line and low voltage) shall be capable of hot patching cold tungsten loads up to full rated capacity without malfunction or change in operating characteristics regardless of control setting.

10. Speed of response of system processor modules to control signal changes shall be no more than 25 milliseconds.

11. Dimmer output shall repeat with respect to the control signal input unit value without hysteresis.

12. Dimmers set to equivalent control signals with equal types and amperage of loads shall not vary from one to another by more than one percent (1%) at any place in the control signal range from full-off to full-on. Dimmer response shall not be phase sensitive with respect to control signal. There shall be exact tracking from one dimmer to the next with no variation.

13. There shall be no visible dimming resolution stepping or flickering regardless of length of fade time or control fader settings.

14. Provide protection from overloads, short-circuiting, and transient voltage. Protection devices requiring reset or replacement must be accessible on the face of the dimming module or dimming cabinet.

15. Circuit Breakers:
   a. Provide input fully magnetic circuit breaker(s) mounted on the face of each dimmer module or cabinet faceplate. Provide one input breaker for each individual dimmer within a module (e.g. one for single module, two for dual modules, etc.).
   b. Input breakers must be rated for full load of the dimmer and must trip at 125% of rated capacity. Input breakers shall be rated for a minimum fault current of 10,000 AIC (120V) or 14,000 AIC (277V).
   c. Acceptable manufacturers: Airpax or approved equal

16. Provide dimmers with a ferrous core toroidal filter choke. This filter choke shall suppress lamp filament or transformer hum and vibration, prevent electromagnetic interference in professional quality audio, video, and computer equipment and limit objectionable harmonics. Laminated E.I. or C.I. type chokes are not acceptable.
   a. Rise Time Full Load (Theatrical Lighting Dimmers): Voltage rise time shall not be less than 500 microseconds measured and installed on site at 90 degree conduction angle from 10% to 90% of output wave form with dimmer operating at maximum load.

C. Dimmer Modules with Bypass
1. Dimmer modules with Bypass shall meet all of the criteria for dimmer modules listed above
2. Modules shall utilize the same chassis form as the dimmer modules
3. Modules shall contain two mechanically held relays
4. Each output in the module shall be configurable to operate as a dimmer or a relay
5. Local override switches shall permit full manual bypass of control signal at each output
6. Breakers shall be fully rated at 20 amps
7. Breakers shall be fully magnetic type

D. Non-Dim Modules
1. Non-dim modules shall utilize the same chassis form as the dimmer modules
2. Modules shall contain two true electrically held relays
3. Breakers shall be fully rated at 20 amps
4. Breakers shall be fully magnetic type

E. Dimmer Control Electronics:
1. Control electronics shall use digital electronic circuitry, be microprocessor based, and be designed specifically for the control of dimming systems. All user operated controls shall be low voltage, use Class II wiring and be electrically isolated from power wiring by means of a UL listed Class II transformer. Appropriate analog to digital conversion shall be acceptable provided circuitry is integral to the control system and not a stand-alone component.
2. System configuration, operating parameters, presets, levels and fade times shall be able to be field modified and shall not require components to be returned to the Manufacturer for such modifications.
3. System configuration, operating parameters, presets, levels and fade times shall be protected against system power failure for a minimum of 10 years. The state of the system status upon restoration of power shall be user selectable.
4. The dimmer control electronics may be capable of being addressed by the IEEE 802.3 Ethernet protocol.
   a. The dimmer control electronics shall be capable of being addressed by an ACN-compliant transport system for the USITT DMX512-A protocol when any lighting control console utilizing the same protocol is plugged into a DMX In Node.
5. Dimmers shall regulate output voltage to maintain constant output RMS voltage as long as input remains over 120V per phase.
6. Dimmer output RMS voltage versus control input signal shall be consistent with a modified square law curve. The dimmer curve shall be stable and shall not require individual curve adjustment devices. The dimming curve shall be predetermined and shall not vary unless modified through control device software.
   a. Modified square law curve shall provide a more uniform output response to control level changes than a standard square law curve.
   b. Other optional curves shall be available for installation through rack and/or control console operations software.
   c. Field adjustment of dimming curve shall not be required.

F. Provide:
1. ETC Sensor3 Racks and ThruPower 500ms rise AF dimmers
2. Architectural dimmer modules as listed in Appendix A

2.5 DMX CONTROLLED PANELBOARDS

A. DMX Motorized Breaker Panel
1. Panels shall provide over-current circuit protection and remote on and off circuit control utilizing motorized circuit breakers in a single wall-mounted enclosure.
2. Panels shall support single, double, and triple pole motorized circuit breakers, and include control electronics, electronics power supply, and isolated technical ground bar.
3. All panels and components shall be ETL or UL Listed.
4. Panels shall be no larger than 20” wide x 6” deep x 70” high.
5. Panels shall be constructed of 16-gauge steel with removable knockout panels to facilitate conduit entry. Front panel shall be easily removable for full access to all connections.
6. Panels shall be convection cooled.
7. Panels shall be fed by 3-Phase 4-wire (3-Phase conductors, 200% Neutral), Isolated Technical Ground and chassis ground 120/208 or 277/480 VAC 60 Hz supply.
8. Panels shall have Main Circuit Breaker protection on input feed.
9. All line, neutral and ground terminals shall accept up to 6 AWG wire.
10. The individual remote controlled circuit breakers shall contain motor driven, mechanically held contacts with ampacity ratings of 15, 20 or 30 amps at up to 480VAC, as required.
11. Each motorized circuit breaker shall have an integral manual override switch with on/off status indication.
12. The motorized circuit breakers shall have the following characteristics:
   a. Respond to control changes in less than 25 milliseconds.
   b. Rated for a minimum of 100,000 mechanical operations
13. The panel control electronics shall operate on single phase, 120-277V AC 60Hz fed from an included 15 amp circuit breaker. Fault current protection shall be 25,000 AIC @ 120 VAC.
14. The panel shall receive DMX512 control protocol. Up to two additional control protocols, including sACN, 0-10V Dimming, Contact Closure, and DALI, shall be available, as required, via on-board interface or accessory card. Addressing shall be set through a user interface.
15. Panels shall support discrete addressing of each breaker.
16. 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components.
17. A voltage barrier shall be provided to separate line voltage and control voltage sections of the panel.
18. Provide:
   a. Electronic Theatre Controls Sensor IQ Intelligent Breaker Panel in configurations and with accessories as listed in the Appendix.

B. Small format DMX Relay Panel (Valade)
1. Panels shall provide remote on and off circuit control utilizing mechanically held relays in a single wall-mounted enclosure.
2. All panels and components shall be ETL or UL Listed.
3. Panels shall be no larger than 14" wide x 3.5" deep x 12" high.
4. Panels shall be constructed of 16-gauge steel with removable knockout panels to facilitate conduit entry. Front panel shall be easily removable for full access to all connections.
5. Panels shall be convection cooled.
6. Panels shall be fed by discrete 20A circuits from nearby branch circuit distribution board.
7. All line, neutral and ground terminals shall accept up to 6 AWG wire.
8. The individual relays shall contain mechanically held contacts with ampacity ratings of 20 amps at up to 277AC, as required.
9. Each relay shall have an integral manual override switch with on/off status indication.
10. The relays shall have the following characteristics:
    a. Respond to control changes in less than 25 milliseconds
    b. Rated for a minimum of 100,000 mechanical operations at full resistive load
11. The panel control electronics shall operate on single phase, 120-277V AC 60Hz fed from an ia nearby 15 amp branch circuit. Fault current protection shall be 25,000 AIC @ 120 VAC.
12. The panel shall receive DMX512 control protocol and sACN. Addressing shall be set through a user interface.
13. Panels shall support discrete addressing of each relay.
14. 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components.
15. A voltage barrier shall be provided to separate line voltage and control voltage sections of the panel.

16. Provide:
   a. Electronic Theatre Controls Unison Foundry Mini Panel in configurations and with accessories as listed in the Appendix.

2.6 NETWORK DATA SYSTEM

A. Equipment Racks
   1. Equipment Racks shall be 19" standard freestanding or wall-anchored equipment racks, as indicated in the drawings. Enclosure shall provide adequate space for all network components and auxiliary equipment as required.
   2. Equipment racks shall be provided with knockouts as required on top, bottom and sides to allow conduit connection as required.
   3. In no case shall loose equipment be permanently mounted outside of a protective equipment rack or cabinet.
   4. Provide finished, blank panels, complete with rack-mounting holes and hardware as necessary.
   5. Label all controls that are contained within this contract as indicated on related drawings or as appropriate. All labels to be engraved and white filled.
   6. Coordinate wall backing requirements for mounting wall-anchored equipment racks with General Contractor.
   7. Network Control Racks (CR) shall contain network components and auxiliary equipment including but not limited to:
      a. Network switches, patch panels, and cable management, as required
      b. Network devices, including network nodes and taps, as required
      c. DMX Combine Merger and Splitter Units, as required
      d. Architectural processors, as required
      e. Uninterruptible power supplies
      f. Additional equipment as indicated on Drawings
   8. The Production Control Panel (PCP) rack shall contain the following elements:
      a. Rack Identification panel
      b. Task Light Panel
      c. Uninterruptible power supply rated to power equipment contained in this rack for 30 minutes.
      d. Blank and vent panels as required.
      e. Theatrical Lighting equipment as indicated on Drawings.
      f. Control panels and equipment for other theatrical systems (e.g., Rigging, Stage Lifts, Variable Acoustics, etc.). Equipment to be supplied and installed in the rack under the work of the respective sections.
      g. Confirm space requirements with other affected contractors in writing prior to fabrication.

B. Network Components:
   1. Network switches shall have the following characteristics and functions:
      a. Switches shall contain (24) auto-sensing ports, supporting 1000BASE-T, 100BASE-TX and 10BASE-T with PoE per IEEE 802.3af or 802.3at as appropriate.
      b. Switches shall be rack-mounted in standard 19" racks.
      c. Switches shall have front panel LEDs that shall report switch traffic, collisions and expansion status. Per port LEDs shall indicate link and partition status for individual connections.
      d. Switches shall have UTP ports on its front face for connecting to nodes and taps via standard 19” patch panel.
e. Should Ethernet wire runs exceed 300 feet, provide switches with fiber ports equal to the number of fiber runs in the system.

f. Acceptable manufacturers:
   1) Cisco
   2) Approved equal

2. UTP network patch panels
   a. Provide Category 5e Patch Bay (or bays as required) for termination of Category 5e wire runs.
   b. Provide Category 5e patch cords as required for connection between the patch bay (or bays), switches and Ethernet Power Supply.
   c. Patch bays shall be rack-mounted in standard 19" racks.
   d. Provide rack mounted standard 19" cable management system for each patch panel.
   e. Patch bays and cable management panels shall be finished in a black anodized finish and shall contain black Category 5e connectors as required.
   f. Acceptable Manufacturers:
      1) Hubbell

3. Fiber Optic network patch panels
   a. Provide Fiber Optic Patch Bay(s) as required, for termination of fiber optic cable runs.
   b. Each patch panel shall be populated with (12) LC Duplex MM adapters.
   c. Patch panels shall include internal cable management.
   d. Provide 1RU label panel above each patch panel with both the appropriate receptacle designation and location description for each patch jack.
   e. Legends shall correspond with receptacle panel legends where applicable.
   f. Patch bays shall be rack-mounted in standard 19" racks.
   g. Patch bays shall be finished in a black anodized finish.
   h. Provide:
      1) Hubbell Fiber Interconnection Shelf, 1RU (FEUR24LCDOM3)
      2) Approved equal

C. Network Cabling:
   1. Fiber Optic Cable (as required for all runs greater than 300 feet)
      a. Contractor to confirm all cable routing distances to determine appropriate use of fiber runs.
      b. Contractor shall specify 50/125µm fiber optic cable as required to support network components.
      c. The cable must exceed the IEEE802.3z Gigabit Ethernet Fiber specification for 50/125µm Fiber.
         1) For Gigabit Ethernet 1000sx over 50/125µm fiber, a modal bandwidth of 500mHz per km in the 850nm wavelength with 500m minimum distance is required.
         2) For Gigabit Ethernet 1000lx over 50/125µm fiber, a modal bandwidth of 500mHz per km in the 1300nm wavelength with 500m minimum distance is required.
      d. The cable must exceed the TIA/EIA 568B Fiber specification.
      e. Acceptable Manufacturers:
         1) Belden F13D006R9
         2) Or approved equal
   2. UTP Cable
      a. The copper cabling and connecting hardware must fully comply with the existing TIA/EIA 568B Standard and with the standard installation of Category 5e products.
      b. The copper cabling should also comply with the TIA/EIA Category 5e standard.
      c. Acceptable Manufacturers:
         1) For non-plenum rated applications:
            a) CommScope 55N4 Ultra II Enhanced Category 5 UTP cable
b) Belden 1583A
2) For plenum rated applications:
   a) CommScope 5504M Ultra II Enhanced Category 5 UTP cable (for plenum rated applications).
   b) Belden 1585A

D. Lighting Systems Computer
1. The lighting systems computer serves as both the Theatrical and Architectural lighting network programming device.
2. Provide one laptop PC with 14” diagonal 16:9 format screen, minimum Intel Core i7 processor (Microsoft Windows 7 compatible) with 8GB of RAM and 500 GB solid state hard drive, CD/DVD-RW drive, 3-USB slots, Wireless–N card. The Computer shall have the following:
   a. Network interface card for direct use over the lighting Ethernet data network.
   b. Provide fifteen foot cable for plug-in to the network receptacle.
3. Acceptable Manufacturers:
   a. Lenovo
   b. Toshiba
   c. Dell
4. System Software
   a. Provide one boxed set of the most current Windows based operating system compatible with the proprietary application software and system configuration.
   b. Provide networking software complete with manuals, technical support resources and CDROM as required allowing on line and off line Owner configuration and operation of all system parameters and dimmer rack configuration settings.
   c. Provide Architectural lighting system software as specified herein.

E. Wireless Network
1. Provide wireless access points (WAP) to provide continuous and consistent access to the available lighting network using wireless remote lighting control units and laptop computers.
2. Wireless switches shall comply with the latest IEEE 802.3 b/g standards.
3. Coordinate the Ethernet protocols (and frequencies) with other areas of work (AV, Automation, Administration, etc.) to ensure that the lighting system has its own dedicated secured channels and does not broadcast SSID information that would allow the system to be compromised. Setup MAC address filtering if nearby networks require it.
4. Each space shall have a distinct SSID and shall be secured using WPA-2 security.
5. Provide a wireless network map showing WAP locations, discrete address, and coordination with other wireless networks.
6. Provide external antenna connectors for auxiliary antennas.
7. Provide software to allow management and configuration of WAPs.
8. Wireless access points shall be provided with pipe mounting or other appropriate mounting hardware, power supply and 25’ Ethernet cable.
9. Manufacturers:
   a. Cisco Systems
   b. 3-Com
   c. Or equal
10. Provide a wireless network for each space listed below:
    a. Proscenium Theatre
    b. Black Box Theatre
    c. Valade Jazz Center
2.7 NETWORK NODES

A. DMX In/Out Nodes – General:
1. DMX In/Out nodes will be located as noted on drawings. Nodes shall be connected via the Ethernet data network on Category 5e wire.
2. DMX In/Out nodes shall be capable of translating Ethernet based protocol into usable signal for output to plug-in peripheral devices employing USITT standard DMX512-A. These nodes shall comply with IEEE 802.3 standards.
3. DMX In/Out nodes shall support Remote Device Management (RDM) protocol.
4. XLR connectors at each node shall be able to be configured to output or allow input for any one frame of DMX512 with normal assignment being sequential. All nodes indicated in the system shall be able to operate simultaneously without data collision or corruption while maintaining recommended minimum and maximum DMX512/RS485 frame length, packet size and refresh rates.
5. DMX distribution over the data network shall be independent of all devices on the system. Regardless of dedicated theatrical lighting devices that may be connected to the various nodes, the DMX distribution system shall be configurable from a PC or other independent control device. The PC or other independent control device shall be provided under this section. Saving and loading of the system configuration to disk shall be supported.

B. Install DMX In/Out Nodes - Type 'EN':
1. Provide nodes with female five-pin XLR connectors within one node box, as shown on the drawings.
   a. Label each receptacle with appropriate designations. All labels to be engraved with white core fill. Provide white acrylic write on surface as shown.
2. Each node shall be powered via its Ethernet connection using Power Over Ethernet (IEEE 802.3.af).
3. Devices shall be mounted at fixed locations and wired as indicated on the drawings.
4. Assembly shall have sheet metal back box and faceplate.
   a. Provide flush mount or surface back box and properly sized face plate as required for each location shown on drawings
   b. Face plate shall match edges of back box in surface mount conditions.
5. Provide quantities and configurations as indicated in drawings
   a. ETC Net3 DMX/RDM Output Gateway

C. 4-Port DMX In/Out Nodes:
1. Devices shall have (4) five-pin XLR receptacles within one node box.
   a. Provide male XLR receptacles for DMX ‘In’ ports
   b. Provide female XLR receptacles for DMX ‘Out’ ports
   c. Label each receptacle with appropriate designations. All labels to be engraved with white core fill.
2. Each node shall be powered via its Ethernet connection using Power Over Ethernet (IEEE 802.3.af).
3. Nodes shall be rack mounted in Network racks and wired as indicated on the drawings.
4. Provide quantities and configurations as indicated in drawings and as required for operation of the system as described herein:
   a. ETC Response 4-Port DMX/RDM Gateway

D. Portable 2-Port DMX In/Out Nodes
1. Device shall have (2) female five-pin XLR connectors within one node box.
   a. Label each receptacle with appropriate designations. All labels to be engraved with white core fill. Provide white acrylic write on surface as shown.
2. Each node shall be powered via its Ethernet connection using Power Over Ethernet (IEEE 802.3af).
3. Devices shall be portable.
4. Connection of Category 5e at nodes shall be via a ruggedized RJ45 connector or what is accepted as industry standard at the time of the installation.
5. Internal components shall be modular in nature and easily replaced as a unit in case of failure.
6. Assembly shall be a sheet metal enclosure and faceplate.
7. Provide 5'-0" Category 5e cable extension for each node.
8. Provide appropriate mounting hardware to mount node onto 1.5" Schedule 40 pipe.
9. Provide:
   a. ETC Net3 Two-Port DMX/RDM Output Touring Gateway

E. Portable Network Full Function Node
1. Provide one (1) 4-Port DMX In/Out Node and one (1) Remote Video Interface in a portable rack enclosure to provide for connection of Designer remote consoles, remote video monitors, focus remote and other DMX devices as required.
2. 120 Volt power.
3. All other network features as described above.

2.8 NETWORK CONNECTION DEVICES

A. General
1. Provide all network connection devices as indicated on the drawings and as specified herein, for installation by Division 26.
2. Coordinate size of device, orientation of circuits, and mounting detail to suite site condition.
3. Device back boxes and faceplates to be sheet metal construction, finished flat black unless otherwise noted.
   a. Provide surface mount or custom flush mount back box and properly sized faceplate as required for each location shown on drawings.
   b. Standard flush mount back boxes to be provided by Division 26.
   c. Faceplate shall match edges of back box in surface mount conditions.
   d. Flush mounted faceplates shall have chamfered edges, finished as per Architect.
4. All standard 19" rack panels to be flanged, black, anodized aluminum.
5. See drawings for device locations and control device schedules for device type, mounting type, and receptacle types and quantities.
6. Receptacles:
   a. 20A Edison (NEMA 5-20 R) duplex panel mounted receptacles
      1) All receptacles shall be of the same manufacture
      2) Color: Black except where specifically noted otherwise
   b. RJ45 panel mounted receptacles
      1) RJ45 receptacles must comply with all Category 5e or greater standards.
      2) Ruggedized locking connector system
      3) Provide:
         a) Neutrik etherCON RJ45 receptacles
   c. Fiber optic panel mounted receptacles
      1) Fiber optic receptacles must be LC-Duplex compatible.
      2) Ruggedized locking connector system
      3) Provide:
         a) Neutrik opticalCON receptacles with SCD-NC rubber sealing covers
   d. Multi-Pin receptacles
      1) Provide ruggedized multi-pin receptacles to mate with cord-mounted connector on device type HLP, portable houselight controller.
7. Labeling:
   a. Label each network receptacle with appropriate designations. All network receptacle labels to be engraved with white core fill, unless otherwise noted.
   b. Provide lamacoid tags for the following information:
1) Maximum length of external Category 5e cable that can be connected without violating the Category 5e standard
2) Circuit designation(s) of each power receptacle. Circuit designations to be verified by Division 26 prior to fabrication.
c. Lamacoid tags to be engraved on black (with white core) with chamfered edges, and shall be securely mechanically fastened to device.

8. Mounting:
a. Devices shall be surface, flush or recess mounted at locations and mounting heights as called out on drawings and device schedules.
b. Provide all requisite mounting hardware for installation of devices. Coordinate all device mounting requirements with Division 26.
c. All holes in mounting brackets to have 1” minimum slotted hole to enable adjustment for field conditions. Provide lock washers on bolts.

B. Console Connection panels – Type ‘CC’:
1. Provide device with one double duplex “clean” power receptacle and control receptacles as shown on the drawings.
2. RJ45 receptacles shall be connected via Category 5e cable to the Ethernet network and shall allow full function nodes or other peripheral portable nodes to be connected to the network.
3. Fiber optic receptacles shall be terminated with 2 fiber cable as specified herein.
4. Portable house light control receptacle shall allow full function of portable house lighting controller including panic and normal functions.

C. Network Taps – Type ‘ET’:
a. Provide device with one duplex “clean” power receptacle and control receptacles as shown on the drawings.
b. RJ45 receptacles shall be connected via Category 5e cable to the Ethernet network and shall allow full function nodes or other peripheral portable nodes to be connected to the network.
c. Fiber optic receptacles shall be terminated with 2 fiber cable as specified herein.

2.9 ARCHITECTURAL LIGHTING CONTROL SYSTEM

A. General
1. The Architectural lighting control system shall be a microprocessor-based control system that works in conjunction with the theatrical lighting control console in rooms where consoles are provided and otherwise independently to set and control auditorium house lighting or studio lighting levels.
2. The system shall control architectural LED house lighting, DMX relay-controlled work lighting and DMX-controlled switching for theatrical circuits as shown on the drawings.
3. The system shall operate through master control panels, preset recall stations and entry panel stations located as shown in the drawings. The system shall also be controlled remotely with a portable master station (specified herein) with plug-in locations as shown in the drawings.
4. The System shall be configured to allow multiple active presets to control architectural lighting, work lights, and theatrical fixtures simultaneously through the use of multiple room assignments.
5. Switching between panels shall not cause flicker or change in lighting levels when setting on panels or House Lighting master station are identical.
6. The System shall have the ability to “snapshot” DMX levels from the theatrical lighting console and record those levels into architectural system presets.
7. When in use, the theatrical console shall override preset levels on a highest takes precedence basis and shall directly control only those dimmed architectural and theatrical circuits within the same performance space.

8. The architectural and theatrical lighting circuits in the performance spaces shall operate independently of the lighting circuits in the lobbies and public spaces. This system shall not control the lobbies and public spaces.

9. All control panels and presets shall be programmed by the Contractor as part of the work of this Section, in coordination with the Architect, Theatre Consultant, and Owner.

10. Provide:
   a. Electronic Theatre Controls Unison Paradigm System

B. Architectural Control Processor
   1. The architectural control processor allows programming and recall of preset lighting states, time clock events and sequences, and control of fade times between presets.
      a. Provide support for a minimum of 99 lighting presets
   2. Provide sufficient quantity of processors for each system to support simultaneous control during preset recall of:
      a. All architectural fixture control addresses
      b. All dimmed and switched architectural circuits
      c. All switched theatrical circuits
      d. One (1) DMX universe for theatrical dimmers and/or fixture control addresses
   3. System operating program shall be stored in electrically erasable programmable read only memory (EEPROM).
   4. Data storage facilities shall retain memory for an indefinite period of time. In case of power failure, the control module shall retain preset memory for minimum of 72 hours.
   5. Provide control system configuration software operating on a PC platform to allow configuration and preset level setting.
   6. Provide in a rack-mount enclosure for installation in standard 19” racks.

C. House Light Panic System
   1. The House Panic Control System instantly brings the architectural lights to full with the push of one button. The system is always enabled at every location, regardless of the state of other control systems. The system must operate independently of emergency power transfer relays or other power failure reliant systems.
   2. House Light Panic System shall include a separate power supply and DMX driver so that house lights can be brought on in the event of failure of primary supply and/or electronics.
   3. House Light Panic control shall be included in all House Lighting Master Stations, including any portable stations.
   4. Operations:
      a. The NORMAL push button is illuminated at all locations whenever Panic System is not activated.
      b. Depressing any PANIC push button illuminates the PANIC push button and turns off illumination of the NORMAL push button at all locations, and causes a control signal from a dedicated set of control electronics and a dedicated power supply to be applied to selected house light dimmers. This causes those house light dimmers to output full line voltage to loads. This state remains until any NORMAL push button is depressed. Depressing any NORMAL push button illuminates the NORMAL push button and turns off illumination of the PANIC push button at all locations, and returns the system to the exact state it was in prior to depression of the PANIC push button.

D. Architectural LED Lighting Dimming & Control Interfaces
   1. Architectural lighting fixtures with LED sources compatible with low voltage dimming will be controlled via DMX data signals generated by the theatrical lighting control systems.
2. Architectural lighting fixtures with LED sources compatible with mains dimming will be controlled directly by dimmer modules in the theatrical lighting dimming system.

3. Low voltage drivers and theatrical system dimmer modules for all LED sourced architectural lighting fixture types shall be tested for full 0-100% dimming range compatibility at the dimming and control manufacturer’s factory.

4. Control interface devices, including control signal nodes and repeaters, shall be rack-mounted or provided in DIN rail enclosures.

5. Fixture interface devices, including device drivers and external power supplies, required between control signals and the LED fixtures shall be provided under Division 26 work.

6. Provide:
   a. DMX output nodes, DMX repeaters, and/or DMX-controlled 0-10V output nodes as listed in the Appendix. Review Division 26 Architectural Lighting documents to confirm quantity of outputs required for control of system.

E. Architectural LED Lighting Emergency Bypass Detection

1. Provide a power loss detection device that will monitor normal power feed and generate a contact closure output to trigger emergency lighting bypass operation upon loss of normal power.

2. Each unit shall provide isolated outputs for connection of multiple devices.

3. Unit shall be compatible with single or three phase systems.

4. Unit shall provide automatic sensing of normal power loss.

5. Unit shall include an integrated circuit breaker for over-current protection and simulation of normal power loss.

6. Unit shall provide a normally-closed input for interface with fire alarm systems.

7. The unit shall be UL924 listed.

8. Outputs shall be configurable as normally open or normally closed.

9. Provide:
   a. Electronic Theatre Controls Emergency Bypass Detection Kit, model EBDK

F. Architectural LED Lighting Emergency Bypass Controller

1. Provide low voltage bypass device that will allow LED sourced fixtures to operate as normal / emergency fittings by sending DMX512 directly to connected fittings. The unit shall override the control signals on associated emergency lighting fittings upon loss of normal power.

2. When in panic mode, the unit can provide a maintained normally open, normally closed, dry contact or +12VDC signal.

3. Each unit shall provide a full universe (512 channels) of DMX control.

4. The unit shall be UL924 listed.

5. Outputs shall be compatible with DMX512 protocol.

6. Provide:
   a. Electronic Theatre Controls DMX Emergency Bypass Controller, model DEBC

2.10 ARCHITECTURAL LIGHTING CONTROL PANELS

A. General:

1. Control electronics shall use digital electronic circuitry, be microprocessor based and be designed specifically for the control of architectural lighting systems. Location, overall dimensions, and quantity of control devices shall be as shown on drawings.

2. Controls shall be low voltage type and use N.E.C. Class II, low-voltage wiring.
   a. Only Belden control cables shall be acceptable.

3. Control device back boxes, where required, shall be standard deep masonry boxes by Square D or equal. Back box depth not to exceed 4” without prior approval.
   a. Provide surface mount or custom flush mount back boxes and properly sized faceplate as required for each location shown on drawings.
b. Standard flush mount back boxes to be provided by Division 26.
c. Faceplate shall match edges of back box in surface mount conditions.
d. Flush mounted faceplates shall have chamfered edges, finished as per Architect.

4. All standard 19” rack panels to be flanged, black, anodized aluminum.
5. Faceplates shall attach to the device with no visible mounting screws. No manufacturer’s logo or other marking shall appear on faceplates unless otherwise noted.
6. Faceplate finishes shall be manufacturer’s standard finish unless otherwise noted by Architect or Architectural Lighting Consultant. Selection of finish, custom or standard color shall be by Architect.
7. Control devices shall be provided with appropriate zone and/or scene descriptions. These descriptions shall be furnished to the Manufacturer prior to fabrication by the Architect or Architectural Lighting Consultant and shall be engraved and filled with color to be selected by Architect. Any silk screened borders, logos, potentiometer graduations, etc. shall use a chemically bonded graphic process which resists removal by scratching, cleaning, or other light abrasive scouring.
8. All slider potentiometers shall have a minimum travel of one (1) inch and shall have a graduated scale marked adjacent to the slider.

B. House Lighting Master Station with Panic System ‘HL’
1. Provide a panel assembly with flush mounted Color Touchscreen Controller capable of the following operations:
   a. Random playback of House Light presets as described herein.
   b. Control of relay-controlled work lighting circuits as described herein.
   c. House Light Panic system control as specified herein.
2. The Color Touchscreen Controller shall include the following:
   a. Back lit user customizable 7” color liquid crystal display with user interface touch screen face-plate.
   b. The Controller shall have multiple pages to enable:
      1) Preset selection and playback
      2) Preset, level and fade time recording
      3) Adjustment of individual dimmed channel and switched work light channel levels/status
      4) Recording of Theatrical Lighting console output into architectural system presets
   c. Products:
      1) Electronic Theatre Controls Unison Paradigm 7” Touchscreen
3. Provide front panel containing all controls as required to operate House Panic System as specified herein.
4. Provide EAO Series 31 Switches as specified above for PANIC, NORMAL controls.

C. Portable House Lighting Master Station ‘HLP’
1. Provide one Portable House Lighting Master Station with all of the features described above in a rugged portable enclosure.
2. Case: Provide sturdy case with carrying handles and rubber feet, as indicated on the Theatrical Lighting drawings.
3. Cables
   a. Provide 1 – 10’, and 1 – 25’ male to female combined power and control cable to mate with associated connection panels.
4. Mating Connectors
   a. Provide mating female multi-pin receptacle in the CC panels as shown on the drawings.

D. House Lighting Master Station ‘HL2’
1. Provide a Color Touchscreen Controller capable of the following operations:
   a. Random playback of House Light presets as described herein.
b. Control of relay controlled work lighting circuits as described herein.

2. The Color Touchscreen Controller shall include the following:
   a. Back lit user customizable 7” color liquid crystal display with user interface touch screen face-plate.
   b. The Controller shall have multiple pages to enable:
      1) Preset selection and playback
      2) Preset, level and fade time recording
      3) Adjustment of individual dimmed channel and switched work light channel levels/status
      4) Recording of Theatrical Lighting console output into architectural system presets

3. Provide:
   a. Electronic Theatre Controls Unison Paradigm 7” Touchscreen

E. Architectural entry stations - Type ‘EP’
   1. Provide push button entry stations in surface or flush mounted box in locations as shown on the drawings. See drawings for push button quantities per device type.
   2. Station shall recall designated preset(s) and may be disabled by the main system control.
   3. LED indicators in switches shall indicate the active preset on the panel.
   4. Stations shall allow multiple presets to be concurrently active.

2.11 THEATRICAL WIRING DEVICES

A. General
   1. Provide all theatrical wiring devices as indicated on the drawings and as specified herein, for installation by Division 26.
   2. Coordinate size of device, orientation of circuits and mounting detail to suit site condition.
   3. Device back boxes and faceplates to be sheet metal construction, finished flat black unless otherwise noted. Provide requisite mounting holes, conduit knockouts, etc.
      a. Provide surface mount or flush mount back box and properly sized faceplate as required for each location shown on drawings.
      b. Standard flush mount back boxes to be provided by Division 26.
      c. Faceplate shall match edges of back box in surface mount conditions.
      d. Flush mounted faceplates shall have chamfered edges, finished as noted or as per Architect.
   4. Receptacles:
      a. Stage Pin Connectors
         1) All 20 amp stage pin receptacles shall be of the same manufacture
         2) Flush mounted female receptacles shall have a screw-driven locking spring to ensure firm fit on face panel
         3) Provide for 20A stage pin connectors:
            a) Union Connector 20-2P&G series
            b) Rosco 2000 series
            c) Bates Connectors
      b. 20A Edison (NEMA 5-20R) duplex panel mounted receptacles
         1) All receptacles shall be of the same manufacture
         2) Hospital Grade to UL 498 Supplement SD
         3) Retention force of grounding pin tested to NFPA 99. Retention force shall not be less than 4 oz.
         4) Color: Black except where specifically noted otherwise
         5) Provide:
            a) Leviton 8300-E
            b) Legrand/Pass & Seymour 8300-BK
      c. 20A Edison (NEMA 5-20R) cord mounted receptacles
1) All receptacles shall be of the same manufacture
2) Hospital Grade to UL 498 Supplement SD
3) Retention force of grounding pin tested to NFPA 99. Retention force shall not be less than 4 oz.
4) Nylon and/or high impact polycarbonate body with screw-open cable gripping jaws
5) Straight body
6) Color: Black and white, black and clear, or clear and white
7) Provide:
   a) Leviton 8319C
   b) Legrand/Pass & Seymour PS5369XHG
   c) Hubbell 8319C
   d) Cooper (Arrow/Hart) 8369
d. Multi-Pin Locking Connectors
   1) All multi-pin receptacles shall be of the same manufacture, including panel mount female and cord mount male and female connectors
   2) Provide cord mounted connectors with appropriate strain relief:
   3) Single cables with double basket weave strain relief
   4) Multiple individual cords with clamping cable glands
   5) Multi-pin receptacles and plugs shall be 19-pin connectors wired for 6 circuits with dedicated line and neutral connections and 7 ground wires.
   6) Provide:
   7) Veam VSC
   8) Approved equal

5. Provide all wiring devices with either internal terminal strips or exterior terminal boxes for interconnection to the dimming and switched power system. All wiring devices may be internally wired at the factory prior to shipping.
   a. Size all terminals as required based on wire sizes indicated on the Electrical Documents.
   b. Terminal strips shall be grounded to the device enclosure.

6. Terminal Boxes:
   a. Provide terminal boxes factory assembled with numbered terminal blocks for field connection by others, as indicated in the drawings and schedules.
   b. All terminal boxes regardless of quantity of circuits shall be the same size.
   c. Provide six spare terminals in each terminal box in addition to the spare circuits indicated in the schedules. Provide 4 ground lugs per box. Size all lugs and terminals as required based on wire sizes indicated on the Electrical Documents.
   d. Sheet metal construction, finish flat black. Reinforce base of terminal boxes as required to take load from multi-cable.
   e. Back box to be clearly labeled with circuit numbers.

7. Labeling:
   a. Label each receptacle with appropriate circuit designation indicated on distribution schedule and drawings. All labels to be engraved on black (with white core) lamicoid tags with chamfered edges. Tags to be securely mechanically fastened to wiring device.

8. Mounting:
   a. Devices shall be surface, flush or recess mounted at locations and mounting heights as called out on drawings.
   b. Provide all requisite mounting hardware for installation of theatrical wiring devices. Coordinate all device mounting requirements with Division 26.
   c. All holes in mounting brackets to have 1” minimum slotted hole to enable adjustment for field conditions. Provide lock washers on bolts.

9. The Manufacturer is responsible for providing all wiring devices to meet all requirements as stated by the National Electrical Code and local code in reference to separation,
isolation, and clearances for all voltages specified, as well as terminal sizes for all cable sizes, cable entry sizes, and exit routes and standoff.

B. Plug Boxes with Flush Receptacles - Type ‘PBR’
1. Provide plug boxes with flush mounted receptacles as shown on the drawings. See drawings for device locations and distribution schedule for device type, mounting type and circuit quantity.
2. Label each receptacle with appropriate switched circuit designation and DMX address or dimmer designation indicated on distribution schedule and drawings.

C. Plugging Strip with Pigtails - Type ‘PSP’
1. Provide plugging strips of standard plug batten construction with pigtail mounted receptacles as shown on the drawings. See drawings for device locations and distribution schedule for device type, mounting type and circuit quantity.
2. Pigtail length shall be as indicated on drawings.
3. Provide pigtail of 12/3 ‘S’ or ‘SO’ neoprene jacketed cable with appropriate strain relief.
4. Label each receptacle with appropriate switched circuit designation and DMX address or dimmer designation indicated on distribution schedule and drawings.
5. Provide with integral control device panels where indicated on drawings.
6. Provide brackets and hardware for mounting boxes. All holes in mounting bracket to have 1” minimum slotted hole to enable adjustment for field conditions. Provide lock washers on bolts.

D. Multi-cable Box with Flush Receptacles – Type ‘MBR’
1. Provide multi-cable boxes with flush mounted receptacles as shown on the drawings. See drawings for device locations and distribution schedule for device type, mounting type and circuit quantity.
2. Provide metal dust caps on cable lanyard captive to back box for each multi-pin receptacle.
3. Provide boxes with forged shouldered eye bolts mounted to reinforced edges of back box for multi-cable strain relief.
4. Label each receptacle with appropriate switched circuit designation and DMX address or dimmer designation indicated on distribution schedule and drawings.

E. Multi-cable Box with Pigtails - Type ‘MBP’
1. Provide multi-cable boxes with pigtail mounted receptacles as shown on the drawings. See drawings for locations of devices and distribution device schedule for device type, mounting type and circuit quantity.
2. Provide metal dust caps on cable lanyard captive to back box for each multi-pin receptacle.
3. Provide boxes with forged shouldered eye-bolts mounted to reinforced edges of back box for multi-cable strain relief.
4. Pigtail length shall be as indicated on drawings.
5. Provide multi-cables built from 75°C Extra-Hard Usage Cords, which consist of specified number of circuits rated 20 amps at 125 volts in accordance with Article 520 of National Electric Code.
6. Strain Relief:
   a. Provide Hubbell Kellems Deluxe Cord type grips correctly sized to restrain permanently attached multi-conductor cables to all multi-cable junction boxes and drop boxes.
   b. Provide Hubbell Kellems Heavy Duty, Single Eye, Closed Mesh Strain relief on each multi-cable extension.
7. Label each receptacle with appropriate switched circuit designation and DMX address or dimmer designation indicated on distribution schedule and drawings.
2.12 SOURCE QUALITY CONTROL

A. All equipment and components shall be factory tested prior to shipping.

B. Assemble in factory any and all system assemblies and subassemblies at Architect or Theatre Consultant's request, for testing in presence of Architect or Theatre Consultant, prior to shipment. Notify Architect at least 3 weeks prior to date when equipment is complete and ready for testing. Make equipment available to Architect or Theatre Consultant in Manufacturer's factory for period of at least 2 weeks for testing prior to shipment.

C. During the test provide test equipment for all testing required and any other testing requested by the Architect or Theatre Consultant.
   1. Test Equipment shall consist of any item that is proprietary to the testing of Manufacturer's equipment. Meters and oscilloscope need not be supplied.

D. Control Testing:
   1. Theatre Lighting Control Console and Network system shall be assembled in factory and tested for control console update time, video refresh rate, remote video picture quality, and any other function requested by Architect.
   2. Architect shall be sole judge of extent of testing necessary and sole judge of acceptability of any system tested.

E. Verification of Performance:
   1. Provide Architect with all test results for verification of system performance.

F. For equipment that requires in-house testing, do not ship any piece of equipment without either written verification of factory testing or written waiver of factory testing from Architect for that particular piece of equipment.

2.13 FABRICATION

A. Fabricate all work in this section in accordance with the Architect’s direction, specifications, approved shop drawings, pertinent project drawings, established trade practices and applicable code requirements.

B. Machine finish all operating parts to standard trade tolerance, fits and finishes.

C. Carry out shop welding in full accordance with the appropriate sections of “Specifications for the Design, Fabrication and Erection of Structural Steel Buildings” of the American Institute of Steel Construction (AISC).

D. Fabrication, assembly and wiring shall be neat and workmanlike throughout.

E. Control desks, racks and cabinets shall be welded assemblies of sheet steel or aluminum or of bar size angles, channels and tees or aluminum extrusions forming rigid enclosures to support internal components.

F. All face panels shall be fully supported on all edges, either internally or by rolling interior edges of panels.

G. All control device faceplate screws to be countersunk.

H. All distribution device faceplate screws to be slotted Phillips pan head type.
I. Wood furniture/cabinet work for control desks acceptable with prior approval.

J. Operating elements shall be mechanically safe and electrically "dead".

K. All steel parts and panels shall be cleaned and primed with rust inhibiting primer. Exterior finishes shall be epoxy resin or baked enamel in matte black or in anodized black aluminum where approved.

L. Control element working face panels shall be heavy aluminum or bakelite. Legends and control and protective device designations shall be engraved in panels, or in permanently attached plates, and located for ready identification.

M. Operating instructions shall be similarly engraved and appropriately located on designated equipment.

N. All panel engraving shall be in Helvetica Regular, height as indicated herein. Engraving shall be ¼" or 3/16" as shown in drawings. In no case shall the engraving be less than 3/16" high without Architect’s approval.

O. All internal wiring shall be factory completed and clearly marked.

P. Field connections shall be made by connector devices and cables as specified in preceding sections.

Q. Dimmer modules, dimmer controllers and other plug-in components may have spade lug and/or receptacle devices for connection.

R. Control relays wherever possible shall be the glass or polycarbonate enclosed plug-in type. Relays shall be acoustically damped.

S. Uniform components shall be used throughout the system. All dimmer, fader and preset controllers shall be physically similar; they may vary in voltage according to the Theatrical Lighting Manufacturer circuit requirements.

T. All wire sizes and insulation to comply with UL standards and local codes and meet or exceed electronics industry standards.

U. All wiring to be harnessed and bound. No loose or randomly routed wires permitted.

V. All printed circuit cards to be suitably racked with numbered and indexed guides. Legends to be provided on panel door.

W. Key all components in this section with locks or key switches alike. Provide six keys minimum.

X. Each receptacle within a wiring device must have a home run to the dimmer rack or DMX controlled panelboard of its hot and neutral. Circuits with more than one receptacle must be paralleled at the dimmer rack. The method of termination must not void UL listing. Circuits with more than one receptacle within a single wiring device may be paralleled within the device and require only one home run of the hot and neutral to the dimmer rack or DMX controlled panelboard.

Y. Minimize feeder inductance by twisting the hot and neutral conductors in long connector strips. Neutral conductor must be at least the same size or greater than the hot conductor.
PART 3 - EXECUTION

3.1 INSTALLERS / INTEGRATORS

A. To establish comparative standards of quality, the provision of equipment and services of this section shall be by one of the following authorized dealers:

Beck Studios, Inc
1001 Tech Drive
Milford, OH 45150
Tel: (513) 831-6650

Fantasee Lighting
14857 Martinsville Road
Belleville, MI 48111
Tel: (734) 699-7200

Texas Scenic Co.
8053 Potranco Road
San Antonio, TX 78251
Tel: (210) 684-0091

Vincent Lighting Systems
36500 Ford Rd.
Westland, MI 48185
Tel: (734) 660-8959

B. Substitution Limitations

1. Any contractor who wishes to be listed and has not been pre-approved must submit qualification information to the Architect. Proposal shall include all of the information listed below:

a. Statements of financial responsibility for the past five fiscal years showing assets and liabilities.

b. List of principal officers and design and service engineers in an organizational structure flow chart.

c. List of not less than 5 projects of similar size and scope completed within the five years on which contractor has provided full services: product engineering, shop drawings, manufacture, installation and commissioning. In each instance, indicate specifics of scope of fabrication and installation. Include a contact list: name, address and phone numbers of person(s) directly responsible for operation and maintenance of equipment in each facility.

d. List of current projects and approximate contract value and completion dates. Include list of names, phone numbers and addresses of owner, owner's representatives and architect.

e. For each above described project, list of names of persons who supervised preparation of shop drawings, manufacture of components, and installation of equipment.

f. List of names of persons who would do project management, product engineering, supervision of shop drawing, and supervision of installation should this contract be awarded.

g. Contract Bond Company information indicating that contractor has bonding capacity for full duration of project. Include list of other bonded projects coinciding with this project.
h. Evidence of ability to undertake custom product engineering to meet specific requirements of project specifications. Provide sample project engineering drawings for custom products and contact information for facility operators where those products have been installed.

2. Standards of Acceptance:
   a. Refer to Paragraph 1.8B - Quality Assurance/Qualifications.

3.2 EXAMINATION
   A. Verification of Conditions: Contractor must examine areas and conditions under which the equipment is to be installed and must notify the General Contractor in writing of conditions detrimental to proper and timely completion of work. Work will not proceed until unsatisfactory conditions have been corrected in a manner acceptable to the Contractor.

3.3 INSTALLATION
   A. Install all work in this section in accordance with the Architect’s direction, specifications, approved shop drawings, pertinent project drawings, established trade practices and applicable code requirements.
   B. Provide site supervision during the installation of electrical work associated with the Theatrical and Architectural Lighting system elements.
   C. Install all work securely, complete with all bolts, nuts, washers, clips, fittings, supports, and other items required for proper installation and operation.
   D. Position all items accurately as indicated on drawings and true to plumb, line and level. Maintain maximum headroom and clearances at all points.
   E. Coordinate work with all other trades to avoid causing delays in construction schedule.
   F. All field welding requires prior approval of the Architect and Contractor’s Structural Engineer.
   G. Carry out approved field welding in full accordance with the appropriate sections of “Specifications for the Design, Fabrication and Erection of Structural Steel Buildings” of the American Institute of Steel Construction (AISC).
   H. Do all cutting, drilling, tapping and approved welding required to properly install work. Obtain Architect’s prior approval for cutting and drilling of existing structural work.
   I. Clean structural steel and fabricated steelwork of rust, scale and foreign matter by grinding; prime with 1 coat of chromated primer; finish with 1 coat of first quality machinery enamel free of skips, runs and saps. Touch up all field connections, welds and abraded places with primer and enamel.

3.4 FIELD QUALITY CONTROL
   A. The installation of the equipment indicated in this section shall be supervised by qualified personnel who are regularly employed by the Contractor for supervision of equipment installation similar to that indicated herein.
   B. Installers must be appropriately skilled and experienced for the type and quality of work.
C. Arrange for all tests and inspections required by the General Requirements.

3.5 SYSTEM STARTUP AND COMMISSIONING

A. Commissioning
1. Upon completion of installation work required by the work of this Section, the Contractor shall perform all required tests and inspections, including but not limited to the Compliance Testing Procedures specified herein.
2. Contractor shall supply all equipment required for the commissioning process including access equipment (personnel lifts, ladders and appropriate protective equipment), test instruments and communications equipment.
3. Contractor shall provide staff to assist in the commissioning process.
4. Compliance Testing Procedures (CTP)
   a. Test all dimmed/switched receptacle circuits:
      1) Polarity
      2) Circuit identification
      3) Assignment to designated device
   b. Test all control receptacles for data integrity
      1) DMX
      2) Ethernet
   c. Test all theatrical control devices for function
      1) DMX Nodes
      2) Remotes
      3) Consoles
      4) Architectural Panels
   d. Test all cables provided as part of this section

B. Lighting Preset Programming
1. Coordinate with the Owner to determine the desired lighting presets including the layout and functionality of touchscreen pages as described herein, button station presets and keyswitch operations.
   a. Preliminary programming of touchscreen control stations shall be completed prior to final system checkout.
   b. Preliminary programming of preset light control stations shall be completed prior to final system checkout.
2. At the Demonstration, the touchscreen layouts, functionality, and preliminary lighting presets will be reviewed by the Owner and changes may be required at that time.

3.6 ADJUSTING

A. Adjust all equipment and components for operation in accordance with the specifications, approved shop drawings and pertinent Contract Drawings prior to the demonstration indicated herein.

3.7 CLEANING

A. Touch up minor abrasions and imperfections as required.
B. Remove from the premises all debris caused by this work. All unnecessary equipment and materials shall be removed from the area(s) of this work upon completion, removed from the job site and disposed of legally at no additional cost to the Owner.
3.8 CLOSEOUT ACTIVITIES

A. Demonstration
1. Upon completion of Commissioning, the Contractor will notify the Architect and Theatre Consultant that system is complete, conforms to specification and is ready for Demonstration.
2. Installed equipment is to be operated for approval and inspected for quality by the Theatre Consultant, the Architect and the Owner.
3. The Theatre Consultant will perform the tests listed in the Compliance Testing Procedures to verify compliance with specifications.
4. Contractor shall supply all equipment required for the Demonstration, including access equipment (personnel lifts, ladders and appropriate protective equipment), test instruments and communications equipment.
5. Contractor shall provide staff to assist in the Demonstration, as necessary.
6. Adjustments or modifications shall be made as directed by the Architect and the Theatre Consultant.
7. Costs of re-inspection and additional testing by the Architect and Theatre Consultant, if required, due to lack of completion and/or errors and omissions shall be paid by the Contractor. This work will be conducted on a time and materials basis, including the Architect’s and Theatre Consultant’s standard hourly rates, and shall be scheduled and approved in writing prior to the re-inspection/testing session.

B. Training
1. Following the equipment demonstration, inspection and final adjustments, provide an instruction session to the Owner’s staff or representatives on the safe operation, care and maintenance of the system.
   a. Provide instruction of not less than eight hours total, in 2 separate sessions.
   b. Instruction shall include, but not be limited to, proper general maintenance of the system, replacement procedures for user replaceable parts, and operating procedure to obtain maximum usage of system.
   c. Deliver all copies of approved Operations Manual to Owner prior to first instruction session, and review it as part of that session.
   d. The first session shall take place in the presence of the Architect or Theatre Consultant and shall occur directly after finish of Completion Checkout. If Owner, Architect judge that any work inspected fails to conform to the specification or is not substantially complete at time of Completion Checkout, postpone instruction session until Owner and Architect judge the entire Lighting System to conform with specification.
   e. The second session shall occur at a time arranged by the Owner no sooner than 1 day and no later than 1 month after first session.
2. Console Operator Instruction:
   a. Provide instruction to Owner or Owner’s selected key Lighting Control Console Operators on the detailed operation of Console. This training shall take place in two separate sessions. Each session shall be no less than four hours and shall take place on site.
3. Timing for all sessions shall be scheduled by the Owner at their convenience.
4. Instruction must be by qualified expert operators who have actual experience with systems in performance conditions.

3.9 PROTECTION

A. Provide full protection from damage, construction dirt and debris for all equipment from the point of installation to testing and commissioning.
B. Remove all equipment protection and clean components thoroughly prior to the demonstration session.

3.10 MAINTENANCE

A. Maintenance Service

1. One month prior to the end of the first year following the date of final systems acceptance, a factory engineer shall be provided to examine, adjust and repair the equipment included in this section which is found to require warranty work prior to the end of the warranty period. This service shall not cover adjustments, repairs or replacement of parts due to negligence, misuse, abuse or accidents caused by persons other than the Manufacturer. All labor and materials which are required to perform this service shall meet or exceed these specifications and shall not compromise the performance of the equipment in any way.

2. Following this inspection and maintenance service, the Contractor shall provide the Owner and Theatre Consultant with a written report itemizing the results of the inspections and the warranty work that was conducted. The Contractor shall also include in this written report recommendations for any corrective actions which the Contractor feels should be taken with respect to the equipment included in this section, but are outside the scope of the warranty agreement.

B. System Programming Updates

1. Contractor shall review system operation and control system programming with the Owner’s representatives. Any required adjustments and changes to the control system programming requested by the Owner shall be performed and completed during the time of the corrective service site visit. All control system programming changes shall be documented by the Contractor.

3.11 ATTACHMENTS

A. Refer to Appendix A of this section for quantities and accessories.

END OF SECTION 11 61 63
SECTION 122413
ROLLER WINDOW SHADES

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Manual roller shades (WT-1).
   2. Motorized roller Shades (WT-2)
   3. Motorized double roller shades (WT-3).
   4. Manual double roller shades (WT-4)

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include styles, material descriptions, construction
details, dimensions of individual components and profiles, features, finishes, and operating
instructions.
   1. Motorized Shade Operators: Include operating instructions.
B. Shop Drawings: Show location and extent of roller shades. Include elevations, sections, details,
fabric width and dimensions not shown in Product Data. Show installation details, mountings,
attachments to other work, operational clearances, and relationship to adjoining work.
   1. Motorized Shade Operators: Show locations and details for installing operator components,
      switches, and controls. Indicate motor size, electrical characteristics, drive arrangement,
mounting, and grounding provisions.
   2. Wiring Diagrams: Power, system, and control wiring.
C. Samples for Initial Selection: For each colored component of each type of shade indicated.
   1. Include similar Samples of accessories involving color selection.
D. Shade Material Samples for Verification: Not less than 3 inches square, with specified treatments
   applied. Mark face of material.

1.3 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of roller shade, signed by product manufacturer.
B. Qualification Data: For Installer.
C. Product Test Reports: For each type of roller shade.

1.4 CLOSEOUT SUBMITTALS
A. Maintenance Data: For roller shades to include in maintenance manuals. Include the following:
   1. Methods for maintaining roller shades and finishes.
   2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes,
      and performance.
   3. Operating hardware.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: Fabricator of products.
B. Source Limitations: Obtain roller shades through one source from a single manufacturer.
C. Fire-Test-Response Characteristics: Provide roller shade band materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Product Standard: Provide roller shades complying with WCMA A 100.1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide either the specified products or comparable products by one of the following manufacturers:
   1. MechoShade Systems, Inc.,
   2. Draper Inc.,
   3. Hunter Douglas, Inc.,
   5. Castec.

2.2 MANUALLY-OPERATED ROLLER SHADES

   1. Basis of Design:
      a. FlexShade by Draper, Inc.,
      b. Mecho/5 by MechoShade Systems, Inc.
   2. Visually Transparent Shade Fabric: Refer to Material Identification List.

2.3 MOTOR-OPERATED ROLLER SHADES

1. Basis of Design:
   a. Motorized FlexShade by Draper, Inc.
   b. ElectroShade by MechoShade Systems, Inc.
2. Visually-Transparent, PVC-Free Single-Fabric Shade: PVC-free cloth fabricated from TPO yarn; Cradle to Cradle certified; with straight bottom hem.
   a. Basis of Design: Draper GreenScreen Revive.
      1) Openness Factor: 1 percent.
   b. Open Basket Weave: EcoVeil 1350 Series by MechoShade Systems, Inc..
      1) Openness Factor: 5 percent.

2.4 MOTOR-OPERATED DOUBLE ROLLER SHADES
A. (WT-3) Motor-Operated Double-Roller Shade: Motor-operated, double roller shades, with [fascia], and related heavy duty mounting systems and accessories.
   1. Product and Manufacturer:
      a. ElectroShade DoubleShades by MechoShade Systems, Inc.
   2. Visually-Transparent, PVC-Free Single-Fabric Shade, Interior Face: PVC-free cloth fabricated from TPO yarn; Cradle to Cradle certified; with straight bottom hem.
      a. Basis of Design: Draper GreenScreen Revive.
         1) Openness Factor: 1 percent.
      b. Open Basket Weave: EcoVeil 1350 Series by MechoShade Systems, Inc..
         1) Openness Factor: 5 percent.
   3. Blackout Shade, Exterior Face: Opaque shade, 0 percent openness factor; straight bottom hem.
         1) Material: 53 percent fiberglass, 45 percent acrylic, 2 percent polyester finish (PVC-free).

2.5 MANUALLY-OPERATED DOUBLE ROLLER SHADES
A. (WT-4) Manually-Operated Double-Roller Shade: Manually-operated, double roller shades, with housing as indicated on Drawings, continuous jamb channels, and related heavy duty mounting systems and accessories.
   1. Basis of Design: DoubleShades by MechoShade Systems, Inc..

2.6 SYSTEM COMPONENTS
A. Provide complete system with side angles, bottom bar, headbox, sponge liner, roller tube, controls, wiring, switches, fascia panel, and necessary accessories and fasteners.
B. Rollers: Electro-galvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging; designed to be easily removable from support brackets; with manufacturer's standard method for attaching shade material. Provide capacity for one roller shade band per roller, unless otherwise indicated.
C. Mounting Brackets: Galvanized or zinc-plated steel, painted to match fascia (where applicable).
D. Fascia: L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; length as indicated on Drawings; removable design for access.
1. Top/Back Cover: L-shaped; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.

2. Pocket-Style Headbox: U-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; with a bottom cover consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing shade roller, brackets, and operating hardware and operators within.

E. Pocket with Ceiling Slot Opening: Six-sided box units for recessed installation; fabricated from formed-steel sheet, extruded aluminum, or wood; with a bottom consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing rollers, brackets, and operating hardware and operators within.

F. Bottom Bar: Steel or extruded aluminum, with metal capped ends. Provide concealed, by pocket of shade material, internal-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.

G. Mounting: As indicated on Drawings, mounting permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.

H. Manual Shade Operating Mechanisms: Manual-operated, with continuous-loop bead-chain, clutch, and cord tensioner and bracket lift operator; in compliance with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
   1. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
      a. Operating Function: Stop and hold shade at any position in ascending or descending travel.

2.7 ROLLER SHADE FABRICATION

A. Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.

B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials, with permanently lubricated moving parts.

C. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings.

D. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting roller, and operating hardware and for hardware position and shade mounting method indicated.

E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

F. Color-Coated Finish: For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
2.8 MOTORIZED ROLLER SHADE OPERATORS

A. General: Provide factory-assembled motorized shade operation systems designed for lifting shades of type, size, weight, construction, use, and operation frequency indicated. Provide operation systems of size and capacity and with features, characteristics, and accessories suitable for Project conditions and recommended by shade manufacturer, complete with electric motors and factory-prewired motor controls, remote-control stations, remote-control devices, power disconnect switches, enclosures protecting controls and all operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with the building electrical system.

B. Comply with NFPA 70.

C. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6 with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.

D. Electric Motors: UL-approved or -recognized, totally enclosed, insulated motor, complying with NEMA MG 1, with thermal-overload protection, brake, permanently lubricated bearings, and limit switches; sized by shade manufacturer to start and operate size and weight of shade considering service factor or considering Project's service conditions without exceeding nameplate ratings.
   1. Service Factor: According to NEMA MG 1, unless otherwise indicated.

E. Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure for [surface] [recessed or flush] mounting. Provide the following devices for remote-control activation of shades:
   1. Individual/Group Control Stations: [Maintained] [Momentary]-contact, three-position, rocker-style, wall switch-operated control station with open, close, and center off functions for individual and group control.

F. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop shade at fully raised and fully lowered positions.

G. Operating Function: Stop and hold shade at any position.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions, and located so shade band is not closer than 2 inches to interior face of glass.

3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.
B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner maintenance personnel to adjust, operate, and maintain system.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Music instrument storage lockers (MESC-1).
   2. High-density sheet music storage (MESC-3).
   3. High-density sheet music storage (MESC-4).
B. Related Sections:
   1. Section 061000 - Rough Carpentry: Blocking in frame walls required to anchor casework.
   2. Section 064000 - Architectural Woodwork: (PLAM).

1.2 ACTION SUBMITTALS
A. Product Data: Manufacturer's data sheets, installation instructions, and maintenance recommendations.
B. Product Test Reports: Indicating compliance of products with requirements, from a qualified independent testing agency.
C. Shop Drawings: Prepared by manufacturer. Include elevations showing casework components, details of each condition of installation, and types and locations of hardware and fasteners. Show fabrication and installation details. Include plans, elevations, sections, details, and attachments to other Work.

1.3 INFORMATIONAL SUBMITTALS
A. Samples: For each color and finish for each exposed casework component.
B. Operation and Maintenance Data.
C. Warranty: Submit sample meeting warranty requirements of this Section.

1.4 QUALITY ASSURANCE
A. Manufacturer Qualifications: Approved manufacturer listed in this section, with minimum 5 years’ experience manufacture of similar products in use in similar environments. Obtain music education storage casework through one source from a single approved manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Deliver, store, and handle music education storage casework in accordance with manufacturer’s recommendations. Ship to jobsite only after roughing-in, painting work, and other related finish work has been completed and installation areas are ready to accept casework and recommended temperature and humidity levels will be maintained during the remainder of construction.

1.6 COORDINATION
A. Coordinate installation of blocking and supports in frame wall assemblies under work of other sections where required for anchoring of music education storage casework.
1.7 WARRANTY

A. Special Warranty: Manufacturer's written warranty indicating manufacturer’s intent to repair or replace components of music education storage casework that fail in materials or workmanship within 10 years from date of Substantial Completion. Failures are defined to include, but are not limited to, the following:
   1. Fracturing or breaking of casework components including doors, panels, shelves, or hardware resulting from normal wear and tear and normal use other than vandalism.
   2. Delamination or other failures of glue bond of components.
   3. Warping of casework components not resulting from leaks, flooding, or other uncontrolled moisture or humidity.
   4. Failure of operating hardware.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Storage Casework Component Load Capacities: Unless otherwise indicated, comply with the following:
   1. Storage Casework Wire-Grille Door Hinge: Each weld capable of resisting 400 lbf pull test without visible damage or permanent deformation.
   2. Storage Casework Full Grille Door Hinge: Full length door capable of supporting 315 lbs. Through open and close cycle without permanent damage.
   3. Sheet Music Storage Casework: Units shall support 35 lb/lin. ft. uniform shelf loading with maximum 1/16 inch deflection.

2.2 PLASTIC LAMINATE MATERIALS

A. PLAM Door Panels and Exposed Surfaces: Flush overlay 3/4 inch thick HDPL.
   1. (PLAM-2) Basis of Design: Refer to Material Identification List and Section 064000 - Architectural Woodwork.
B. Particleboard: ANSI A208.1, minimum 43 lb/cu. ft. density.
C. Particleboard Thermoset Panels: Particleboard finished with thermally-fused polyester surfacing on both sides meeting performance properties of NEMA LD 3 for VGS grade, edge-banded to match PLAM faces.
D. Plywood Thermoset Panels: Plywood finished with thermally-fused polyester surfacing on both sides meeting performance requirements of NEMA LD 3 for VGS grade, edge-banded to match PLAM faces.
E. Polyethylene Shelves: High-density, one-piece, blow-molded or polyethylene, with radiused front edge, for abuse-resistant shelves.

2.3 INSTRUMENT STORAGE

A. (MESC-1) Music Instrument Storage Lockers: Modular instrument storage casework with integral bases, adjustable levelers, and through-bolted fastening, enabling owner reconfiguration of unit layout.
B. Components and Materials:
   1. Plastic Laminate: (PLAM-2), unless noted otherwise.
2. Side Panels and Divider Panels: Particleboard thermoset panel, 3/4 inch thick. Side panels machined to accept unit-to-unit through-bolting.
4. Open Casework: Provide casework without doors.
   a. Provide for casework indicated.
5. Panel Edge Banding: Matching PLAM faces, 3 mm thick, heat-bonded, with beveled and profiled edges and corners.
6. Shelving: Sized with adequate gap between shelving and casework side panels to allow air movement inside casework.
7. Unexposed Surfaces: Particleboard thermoset panel, 3/4 inch thick. Side panels machined to accept unit-to-unit through-bolting.
8. Hardware: Provide both of the following:
   a. Cam Padlock Hasp: Surface-mounted, steel; finished to match other hardware.
   b. Built-in Combination Locks: Key-controlled, three-number dialing combination locks.

C. Shelving: Sized with adequate gap between shelving and casework side panels to allow air movement inside casework.
   1. Up to 27 inches wide: Removable molded polyethylene shelf, with impact-resistant, radiused front edge, mounted to cabinet wall with self-locking clip.
   2. Over 27 inches wide: For large instrument casework: Removable formed polyethylene shelf, ribbed, with high-impact-resistant, radiused front edge, supported by steel tube frame.
   3. Corner cabinet revolving shelving: 0.053 inch min. thickness steel sheet bolted to revolving steel center post, with radiused hardboard deflector panel.

2.4 SHEET MUSIC STORAGE
A. (MESC-3): Music Library High-Density Storage: Sheet music storage casework in wheeled retractable units providing high-density storage, adjustable to fit most sizes of published sheet music, enabling owner reconfiguration of unit layout.
B. Unit Configurations:
   1. Unit Type: 7-shelf units, 92''H with 4 adjustable shelves and 3 fixed
   2. Standard Compartment: 10.5''H x 13''D. Each unit is 44''D and 16''W in the closed position.
   3. Oversized Compartment: 10.5''H x 16''D. Each unit is 44''D and 19''W in the closed position.
C. Components and Materials:
   1. End Panels: Particleboard thermoset panel, 3/4 inch thick.
   2. Shelving: Plywood thermoset panel, 3/4 inch thick. 7-shelf unit with 4 adjustable and 3 fixed shelves, with metal book supports.
   5. Guide Frame: 1 by 1 inch by 16 gauge/0.053 inch steel tubes, factory finished, with limiting cable, bumpers, and hat channel wall anchor.
   6. Casework Panel Color: As selected by Architect from manufacturer's standard colors.

2.5 HIGH-DENSITY OPERABLE STORAGE
A. (MESC-4) High-Density Music Library Storage: Provide manufacturer's standard mobile storage shelving systems and components. Where components are not otherwise indicated, provide manufacturer's standard components as required for a complete system.
B. Inserts: Furnish required concrete inserts and similar anchorage devices for installing track system, and furnish other components of work where installation of devices is specified in another Section.
C. Tracks: Steel rails with tops machined to mate with guide wheels and with ends designed to provide smooth, secure continuity between sections without field welding. Provide mounting brackets, anchorage devices, adjustable leveling devices, and stops at terminations of rails to prevent carriages from running off track ends.
   1. Mounting: [Surface mounted] [Recessed].

D. Carriages: Rigid frames consisting of C-shaped cold-formed steel beams and cross beams, designed to allow secure anchorage of shelving units.
   1. Wheels: Manufacturer's standard number of bearing-mounted, steel wheels, precision ground to mate with tracks.
   2. Bumpers: Provide two rubber bumpers with minimum depth of 1/2 inch each side.

E. Carriage End Panels: Full depth and height of shelving units. Provide at [the operating end] [both ends] of each range.
   1. Material: High-pressure decorative laminate.

F. Mechanical Assistance:
   1. Drive Systems: Geared transmission and chain systems with tensioning device to provide mechanical assistance and uniform movement along entire length of each carriage. Permanently shielded and lubricated.
   2. Drive Shaft: Continuous tubular or solid steel shaft, capable of transmitting torque from drive system without distortion.
   3. Locking Pins: Located on range end panels to allow locking of individual range carriage when depressed.

G. Steel-Case Shelving: Shelving consisting of full end, top, and back panels, with end panels made to receive adjustable shelves in slots or to receive clips to support adjustable shelves. Configure units for mounting on mobile carriages.

H. Steel Four-Post Shelving: Shelving consisting of four angle-iron uprights per section, with adjustable shelves resting on shelf supports hung on uprights. Configure units for mounting on mobile carriages.

2.6 ACCESSORIES

A. Filler Panels and Closure Kits: 3/4 inch thick particleboard thermoset panels matching cabinet side panels. Provide the following, cut to fit field conditions, where indicated:
   1. Wall filler between cabinet side and wall.
   2. Top filler between cabinet top and wall.
   3. Top of cabinet closure panel between cabinet and finished ceiling or soffits.
   4. Finished back panel for exposed cabinet backs.

2.7 HARDWARE

A. Butt Hinges: 2-3/4 inch, 5-knuckle steel hinges made from 0.090 inch thick metal, ANSI/BHMA A156.9, Grade 1, with powder-coated finish, through-bolted to door and side panels. Provide 2 hinges on compartment doors, and 4 hinges on full-height doors.

B. Slide Latch: 0.105 inch min. thickness steel, with padlock eye, powder-coat finish, through-bolted to panel door and side panel. Latches securely without padlock. Provide with clear plastic label holder with numbering system.

C. Panel Connectors: 1/4–20 by 1.77 inch panel connectors, with steel thread inserts, powder coated to match panels.
D. Cabinet Levelers: Leveling glides with 3/8 inch diameter threaded steel rod in steel corner brackets, minimum two each per cabinet side, accessible from within unit, and concealed in completed installation.

E. Fasteners: Manufacturer-recommended fasteners as required for casework substrate and project performance requirements, consisting of one or more of the following:
3. Expansion Anchors in Concrete and Concrete Masonry Units: Carbon-steel, zinc plated.

2.8 FINISHES
A. Steel Sheet, Steel Wire, and Exposed Fasteners: Urethane-based electrostatic powder coating, color as indicated.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine casework installation areas for compliance with requirements for installation tolerances, location of blocking and other anchoring reinforcements, and other existing conditions affecting installation and performance of casework. Proceed with casework installation upon correction of unsatisfactory conditions.

3.2 CASEWORK INSTALLATION
A. Install plumb, level, and true; using integral levelers. Install in accordance with manufacturer’s recommendations and approved submittals.

B. Install hardware uniformly and precisely. Set hinges snug and flat. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.

C. Adjust casework and hardware so doors and drawers operate smoothly without warp or bind and close with uniform reveals.

3.3 HIGH-DENSITY STORAGE INSTALLATION
A. Level and plumb tracks to a tolerance of 0.09 inch in 120 inches with no more than 0.06-inch variation between adjacent rails. Use permanent shims or non-shrink grout as indicated by manufacturer.

B. Surface-Mounted Track Systems: Install underlayment, ramps, and finish flooring according to manufacturer’s written instructions and flush with track surfaces. Do not extend ramps beyond ends of carriages.

C. Carriage Installation: Mount mobile carriages on track system and adjust for smooth operation. Provide non-moving carriages securely fixed to rails where indicated.

3.4 INSTALLED WORK
A. Repair or replace defective work as directed by Architect upon inspection.
B. Clean casework surfaces. Touch up, refinish, or replace damaged components in a manner acceptable to Architect.
C. Turn over operation and maintenance instructions to Owner.
D. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain mobile storage shelving.

END OF SECTION
SECTION 126100

FIXED AUDITORIUM SEATING APPENDIX

BASIS OF DESIGN IMAGES
Basis of Design

Proscenium Theatre

Basis of Design

Valade Center

END OF APPENDIX 12 61 00
SECTION 126100

FIXED AUDITORIUM SEATING

PART 1 GENERAL

1.1 SUMMARY

A. The work in this section includes the fixed auditorium seating system within the following spaces:
   1. Proscenium Theatre
   2. Valade Jazz Center

B. Section Includes
   1. Furnish and install all elements of the fixed auditorium seating system and associated accessories.
   2. Work Results:
      a. Provide a complete, working and code compliant fixed auditorium seating system.
      b. Provide fully coordinated and engineered equipment, installation, supervision and commissioning for the major systems and associated accessories as required for each space.
      c. Provide all material, components, accessories and services required to provide the work as specified herein, elsewhere in the project documents and/or as shown on related drawings.
      d. Consult and coordinate with other affected work and contractors throughout the course of the work contained herein.

C. Products Supplied But Not Installed Under This Section:
   1. Specified seat fabric of the same dye lot issued to Loose Seating Contractor for upholstery of loose furniture chair specified under Division 12. Provide 2 yards per loose chair.
      a. Proscenium Theatre – 14 chairs
      b. Valade Jazz Center – 18 Chairs
   2. Extra materials as listed in Paragraph 1.7A, Extra Materials.

D. Related Requirements:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications apply to this Section.
   2. Examine Contract Documents for requirements that directly affect or are affected by Work of this Section. A list of those Documents and Sections includes, but is not limited to the following:
      a. Division 01 – General Requirements
      b. Division 03 – Concrete
         1) Fastener requirements
         2) Floor box location and blockouts
         3) Mechanical diffusers
      c. Division 04 – Masonry
         1) Fastener requirements
      d. Division 05 – Metals
         1) Structural steel supporting the work of this section
      e. Division 09 – Finishes
         1) Adjacent walls and floors
         2) Metal fabrication
      f. Division 23 – Mechanical
Division 26 – Electrical
1) Section 265561 – Theatrical Systems Electrical Requirements
2) Conduit, wire, pull boxes, junction boxes and miscellaneous hardware and components as required for a complete electrical installation
3) Terminations and testing of system continuity

1.2 PRICE AND PAYMENT PROCEDURES

A. Refer to Division 01 - General Requirements for information regarding price and payment procedures.

1.3 REFERENCES

A. Abbreviations:
1. The following abbreviations and acronyms are relevant to this Section and are in addition to those defined in Division 01 – General Requirements:
a. UL: Underwriters Laboratories

B. Definitions
1. The following definitions are relevant to this Section and are in addition to those defined in Division 01 – General Requirements:
a. In all cases where a device or a part of equipment is referred to in a singular manner within the contract documents, it is intended that such a reference shall include all devices required to complete the installation in accordance with the project documents.
b. “Architect”: All references to the “Architect”, Hamilton Anderson Associates, will refer to the process by which the indicated action or decision regarding the work in this section will be administered. All such actions shall be initiated with or by the Architect, who will disseminate all pertinent information and documents to, as well as coordinate all efforts and site visits with, the Theatre Consultant and all other project consultants who may have design responsibility relating to the work in this section.
c. “Theatre Consultant”: Auerbach + Associates, Inc. (d.b.a. Auerbach Pollock Friedlander). The Theatre Consultant will be party to all actions and decisions regarding the work contained in this section.
d. “Other Project Consultants”: Acoustical Consultant, Electrical Engineer, Structural Engineer, or Mechanical Engineer as is applicable to a particular issue.
e. “Contractor”: Manufacturer / Installer responsible for the fabrication and installation of the work contained in this section.
1) Contractors involved with other work shall be indicated with a specific trade preceding the word “Contractor” (i.e. General, Electrical, etc.).
f. "Owner": Authorized personnel representing Wayne State University.
g. "Furnish": Purchase and/or fabricate and deliver to project site.
h. "Install": Physically install the items in their proper location(s) on the project site.
i. "Provide": Furnish and install complete.

C. Reference Standards:
1. Reference Division 01 for general project references and standards.
2. References to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies will refer to the latest edition of such publications adopted and published prior to submittal of the bid. All such codes and standards will be considered a part of this specification as if they were fully included herein.
3. If an applicable code or standard permits work of lesser quality or extent than this specification, then this specification and the related drawings will govern.

4. Comply with national, state and local codes.

5. Comply with national, state and local labor regulations and requirements.

6. The following standards apply to the work of this Section. It remains the Contractor’s responsibility to confirm and comply with all industry standards that are applicable to the work of this Section.
   b. Americans with Disabilities Standard for Accessible Design
   c. Local Authority Building Regulations
   d. Local Authority Licensing Regulations

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. The Contractor is required through drawings, memos and meetings to properly coordinate the work with the other sections as necessary to complete the work of this section.

B. Pre-Installation Meeting:
   1. Refer to Division 01 - General Requirements for information regarding pre-installation meeting with the General Contractor.

C. Sequencing:
   1. The delivery and installation of the equipment in this section shall be coordinated with other work which may be in conflict with or which must be completed before the work under this section may be installed, including:
      a. Principal foundation work (see Architectural Drawings)
      b. Installation of associated electrical work (see Electrical Drawings)
      c. Drywall, mudding, sanding or painting of ceilings and walls
      d. Sanding or application of finishes to floors

1.5 ACTION SUBMITTALS

A. All submittals shall be submitted in accordance with Division 01.

B. All submittals shall be submitted in a timely manner, allowing sufficient time for adequate review and possible resubmittals without jeopardizing the project schedule.

C. Submittals will be reviewed, accepted and field dimension verified prior to proceeding with the fabrication of the work in this section.

D. All submittals shall leave space available for review stamps and comments.

E. The Architect and Theatre Consultant shall only mark one set of drawings per submittal with comments. Drawing markups will be provided on PDF files provided by the Contractor or on paper drawings which shall be scanned and returned electronically.

F. Provide full insurance against loss or damage during shipment. Furnish certifications of such coverage to the General Contractor not less than 60 calendar days prior to the shipment of any equipment.
G. Review all pertinent project Contract Documents. Following this review, provide to the Architect and General Contractor any additional information required to make a fully functioning system. In addition, the Manufacturer shall indicate maximum accepted wire size as it relates to termination points on their equipment.

H. Product Data:
1. Where standard manufacturer parts are used, submit current product literature describing component, manufacturer's recommended applications, load ratings, safety factors and dimensions. The data shall include all information which indicates compliance with the specifications herein.
2. Clearly indicate specific component and applicable options.

I. Shop Drawings:
1. Provide shop drawings on D size minimum (24” x 36”) sheets.
2. Include a cover sheet with a drawing index including the sheet number and title for each sheet in the set.
3. Provide a 4” x 4” area near the title block for review stamps and comments. This area should be in relatively the same location on each sheet.
4. Provide a minimum of one sheet for each seating level.
5. Provide ¼” scale layout plan(s) clearly indicating seat widths, dimensions for coordination for seat mounting, aisle widths and row-to-row clearances.
6. Provide ½” scale details showing relationship of seat rows, indicating seat back to back spacing and clear aisle accessway.
7. Provide complete, fully dimensioned, large scale detailed fabrication drawings of all major components. Include plan or schedules with quantities of each seat size, removable seats, transfer arm seating, end panel lights, and all other accessories.
8. Provide plan of electrical junction box locations and details.
9. Provide plan of row letter and seat number layout.
10. Provide requisite schematics, plans and sections indicating assembly and installation of components.
11. Provide indications by arrow and boxed caption of all variations from contract drawings and specifications, except where variation is indicated as acceptable.
12. Provide power requirements, one-line riser diagrams and installation circuit diagrams for electrical equipment. Show all required wire sizes and counts between all components. These shall be provided within 30 days of Contract Award.
13. Provide detailed drawings of trolley for transport and storage of ‘removable’ seating.
14. Provide a full Bill of Materials to be supplied, including quantities, manufacturer, manufacturer's part number, reference to applicable drawings, etc.
15. Per the requirements of the approved schedule, provide a provisional set of shop drawings with all required information included. A revised set of drawings shall be provided after site verification measurements can be taken. The second set shall show any modifications to the layout due to unexpected site conditions.
16. Shop drawings shall provide sufficient detail to show fabrication, installation, anchorage and interface of the work of this Section with the work of adjacent trades.
17. Responsibility to prevent or remedy conflicts with any floor element shall rest solely on the Contractor.
18. Responsibility for providing a seating layout that meets prevailing code requirements, as demonstrated in the Contract Documents, rests with the Contractor.

J. Samples:
1. Submit samples for approval as per the approved project schedule.
2. Submit samples of each of the following elements in each color, finish, pattern and texture specified per the terms of the Works Contract. If qualities of an element have not been specifically indicated herein, submit manufacturer's color charts or samples of actual
materials indicating the full range of standard colors, finishes, patterns and textures available. The samples shall include, but are not limited to:

a. Provide two 30” square “quality” samples of each seating fabric.
b. Manufacturer’s color charts or actual samples of electrostatically applied powder finishes to be used on exposed parts.
c. Manufacturer’s color charts or actual samples of plastics to be used on seat backs or bottoms.
d. Wood and plywood materials with finish samples for color selection.
e. Seat and back cushion.
f. Seat pan assembly with padding and upholstery.

3. Additional samples must be submitted within 14 days of Architect’s written request.

K. Certificates
1. Provide manufacturer’s certificate stating materials meet fire performance characteristics specified herein.
2. Provide test certificates for specified performance testing.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents:
1. Submit documents in accordance with Division 01 - General Requirements.
2. At the time of acceptance testing, submit three (3) copies of parts lists and maintenance instruction sheets.
3. Within 60 days of the acceptance testing, submit one (1) set of reproducible "as built and approved" drawings showing all equipment as installed. These drawings shall include all adjustments made during the checkout process.
4. Submit operation and maintenance manuals with the “as built and approved” drawings. These manuals shall include all comments and adjustments made during the acceptance and review processes. Each manual shall be bound in an individual binder with the project name on the front cover and system identification on the spine. The manuals shall include:
   a. Complete parts list for all equipment and telephone numbers for the authorized parts and service distributors.
   b. Instructions as to the safe operation for all equipment.
   c. Recommended maintenance schedule for all component parts
   d. Recommendations for cleaning, maintaining and touch-up of all finished surfaces
   e. Provide specific recommendations for cleaning upholstery, including precautions against materials and methods which could damage upholstery fabric.
5. Where specific elements do not require manuals, instruction sheets as to care and handling shall be provided.
6. Certificates of flame resistance as required herein.
7. Warranties as required herein.

B. Submit verification that all punch list items have been rectified. Such written verification will be required for project closeout and initiation of the warranty period.

C. The record documents shall be reviewed by the Architect and Theatre Consultant, and all modifications to the documents stemming from this review shall be made as required.

D. Above submissions are required as a condition for final approval of the work.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials:
1. Deliver stock of maintenance material to Owner. Furnish the following to match those installed and taken from the same production run, packaged with protective covering for storage and identified with appropriate labels:
   a. Seat and back covers in a quantity equal to five percent (5%) of each type of chair and each color provided, with covers prorated to sizes of chairs used.
   b. Provide LED end panel light assemblies in a quantity equal to five percent (5%) of end panel lights installed.
   c. Provide mounting hardware for all mounting conditions equal to five percent (5%) of chairs installed.

1.8 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Refer to Division 01 – General Requirements.

B. Qualifications:
   1. All equipment and installation to be the responsibility of a single Contractor, who shall own and operate their own manufacturing facility for the fabrication of theatrical seating equipment, and be regularly engaged in the fabrication of such equipment. Fabrication of such equipment shall comprise no less than 90% of the Contractor’s business.
   2. The Contractor shall have been continuously engaged in the fabrication and installation of equipment of the type indicated herein for no less than five years.
   3. The Contractor shall have under their control all parts composing the complete chair including castings, steel, plywood, fabric, and accessories, as well as mounting and installation components. Contractor shall do all fabrication and coordinate installation, and shall maintain thorough test and inspection procedures to assure uniform high quality of all raw materials used as well as the finished product.
   4. The Contractor shall have, at the time of bid, a current contractor’s license and shall know, understand, and have the required documentation to work in the State of Michigan. This license shall be maintained throughout the course of the work of this contract.

C. Contractor is responsible for proper installation, operation and safety of all component equipment.

D. Contractor is responsible for the complete design and engineering of all systems described herein. Contractor shall confirm project details and, if necessary, suggest modifications to the criteria established herein in order to maintain the design intent.

E. Errors and omissions within the Contract Documents shall not relieve the Contractor and the General Contractor of the responsibility for providing a properly functioning installation of the system as described herein.

F. Mock-Ups:
   1. Following approval of shop drawings and samples indicated above, and prior to fabrication, a mock-up shall be provided for quality review, verification and testing by the Architect, Theatre Consultant and Owner.
   2. The mock-up for quality review shall meet the following criteria:
      a. Provide a minimum of two (2) chairs including selected fabric, finishes, etc.
      b. One of the chairs of the mock-up will include an ADA transfer arm as specified herein; the other shall have a fixed decorative end standard with integral end panel light as specified herein.
      c. The mock-up should include the actual widths of chairs to be provided.
   3. Fabrication will not proceed until written approval of all mock-ups has been received from the Architect.
4. It shall be the Contractor's obligation to provide shipping of the mock-up to the Architect's office and, following installation, to the job site. Following approval of the finished installation, the mock-up shall be turned over to the Owner.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage and handling shall be coordinated with the General Contractor and shall meet all requirements described in Division 01.

B. Packing, Shipping, Handling and Unloading
1. All equipment shall be appropriately and substantially packed for shipment.
   a. Packaging should include humidity resistant wrapping with desiccant as appropriate to protect contents. Contractor shall ensure that seating and related materials are delivered to the job site in their original and undamaged cartons bearing the manufacturer's name, product name and stock numbers.

2. All equipment containers shall clearly indicate the equipment contained, "front", "top", "fragile", the project name, and theatre site allocation. Include packing and shipping lists for each container.

3. All shipping costs to the job site are the responsibility of the Contractor. The shipping method/company is at the total discretion of the Contractor in order to meet the published project schedules.

C. Acceptance at Site
1. Coordinate responsibility for acceptance of material and equipment at job site with the General Contractor.

2. The Contractor shall be responsible for acceptance of the fixed audience seating system components at the job site, confirming that all quantities and counts are correct and for keeping accurate logs and records of such information.

D. Storage and Protection
1. Upon delivery, the materials shall be stored in their original cartons under protective cover in a dry and clean location, off the ground. Materials shall be stacked or positioned as directed by the Contractor. Delivered materials which are damaged or otherwise not suitable for installation shall be removed from the job site and replaced with acceptable materials.

2. Replace, at no additional expense to the Owner, all equipment and materials which are damaged during storage or handling.

1.10 SITE CONDITIONS

A. Existing Conditions:
1. Verify all conditions at job site. Promptly report variations and obstructions to the Architect. All additions or corrections are to be requested through the General Contractor prior to fabrication.

B. Environmental Requirements:
1. Coordinate all environmental requirements for all materials provided and installed under this contract.

C. Field Measurements:
1. Field measurements must be taken prior to preparation of final shop drawings and prior to fabrication to ensure proper fitting of work. Allow for adjustments during installation whenever taking field measurements.
2. Should field measurement of site conditions alter the design or installation of system elements from the approved shop drawings, revised shop drawings shall be reissued for review.

1.11 WARRANTY

A. Comply with the warranty requirements of Division 01 and the following.

B. The Contractor shall warrant materials and workmanship of systems and equipment as free of defects. The Contractor shall guarantee in writing the repair or replacement within 30 days of any item found defective during a period of one (1) year following date of final acceptance. Ordinary wear and damage due to improper usage are excepted.

C. The Contractor shall warrant the workmanship of installation services provided under this section for a period of five (5) years following the date of final acceptance. Ordinary wear and damage to improper usage are excepted.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. To establish comparative standards of quality, the equipment and services of this section shall be by one of the following manufacturers:

   Ducharme Seating  
   9275 rue le Royer  
   Saint-Léonard, Québec  
   Canada H1P 3H7  
   Tel: (514) 438-2772

   Irwin Seating Company  
   3251 Fruit Ridge NW  
   Grand Rapids, MI 49544  
   Tel: (616) 574-7400

   Series Seating  
   20900 NE 30th Avenue  
   Suite 901  
   Miami, FL 33180  
   Tel: (305) 932 4626

B. Substitution Limitations
1. Any contractor who wishes to be listed, and has not been pre-approved, must submit qualification information to the Architect. Proposal shall include all of the information listed below:
   a. Statements of financial responsibility for the past five fiscal years showing assets and liabilities.
   b. List of principal officers and design and service engineers in an organizational structure flow chart.
c. List of not less than 5 projects of similar size and scope completed within the five years on which contractor has provided full services: product engineering, shop drawings, manufacture, installation and commissioning. In each instance, indicate specifics of scope of fabrication and installation. Include a contact list: name, address and phone numbers of person(s) directly responsible for operation and maintenance of equipment in each facility.

d. List of current projects and approximate contract value and completion dates. Include list of names, phone numbers and addresses of owner, owner's representatives and architect.

e. For each above described project, list of names of persons who supervised preparation of shop drawings, manufacture of components, and installation of equipment.

f. List of names of persons who would do project management, product engineering, supervision of shop drawing, supervision of installation should this contract be awarded.

g. Contract Bond Company information indicating that Contractor has bonding capacity for full duration of project. Include list of other bonded projects coinciding with this project.

h. Evidence of ability to undertake custom product engineering to meet specific requirements of project specifications. Provide sample project engineering drawings for custom products and contact information for facility operators where those products have been installed.

2. Standards of Acceptance:
   a. Refer to Paragraph 1.8B - Quality Assurance/Qualifications.

2.2 SYSTEMS DESCRIPTION

A. Refer to ‘TS’ Series Contract Drawings for seating layout plans and to architectural and structural drawings for floor and riser plans.

B. The seating layout drawings indicate acceptable seat widths and quantities at each width. Proposed manufacturer’s alterations from this layout shall be explained in the shop drawings.

C. Layout Requirements:
   1. Seating layout shall conform to critical aisle dimensions as indicated on the Drawings. These dimensions are based on project code requirements.
   2. Actual makeup of rows and requisite seat widths shall be the responsibility of the Contractor and shall be based on the Contractor's own field measurements and Theatre Consultant’s review of final shop drawings.
   3. The chairs must stagger from row to row on the centerline of the theatre to maximize vertical sightlines. End of rows shall align as indicated on the Drawings.
   4. In rows which contain varying width chairs, the following criteria shall generally be followed:
      a. A narrow seat is to be mounted adjacent to an aisle.
      b. A wide seat is to be mounted adjacent to side-walls or railing.
      c. The remaining varying width seats shall be distributed throughout the row so that the narrow seats are not mounted adjacent to one another and the overall quantity is at the absolute minimum.

2.3 DESIGN CRITERIA

A. All auditorium seating must be designed, manufactured and installed to:
   1. Perform satisfactorily in their intended situation and under their expected conditions in use.
   2. Have sufficient strength to meet their intended conditions of use.
3. Be free from any dimensional inaccuracy or distortion likely to affect its installation or operation.
4. Ensure that they do not contain any material which by direct contact or otherwise can be detrimental to the health and safety of the user.

B. Overall front to back envelope with seat in upright position shall not exceed 21” without notifying Architect in writing.

C. The audience seating shall be fabricated using molded foam cushions for maximum comfort, using materials which are carefully selected to be free of defects, objectionable projections, or irregularities. Smoothly round corners, edges and exposed fasteners to present least possible snagging and pinching hazards.

D. Basis of design:
   1. The basis of design for the fixed and removable auditorium seat shall be the following with special components as indicated herein or an approved equal:
      a. Proscenium Theatre
         1) Basis of design appearance:
            a) Ducharme – Model Arte
               1) 35” high back with wood back panel, Red Oak veneer on exposed sides, Cherry stain TBD by architect
               2) Top of back cushion is held short to create a reveal.
               3) Upholstered seat with wood bottom, Red Oak veneer, Cherry stain TBD by architect
               4) Wood aisle end panel with angled back and block front, Red Oak veneer, Cherry stain TBD by architect
               5) Solid wood arm rests, Cherry stain TBD by architect
               6) Concealed low voltage LED end panel lights
               7) Fabric: Maharam, Divina by Kvadrat 460730 color 173
               8) Recessed row letters
               9) Recessed seat numbers
               10) Recessed donor tags
            b. Valade Jazz Center
               1) Basis of design appearance:
                  a) Series – Model Bravo
               2) 35” high back with curvedwood back panel, Red Oak veneer on exposed sides, Cherry stain TBD by architect
               3) Maximum seat envelope 19”.
               4) Top and sides of back cushion are held short to create a reveal.
               5) Upholstered seat with flat wood bottom, Red Oak veneer, Cherry stain TBD by architect
               6) Wood aisle end panel with angled back and block front, Red Oak veneer, Cherry stain TBD by architect
               7) Solid wood arm rests, Cherry stain TBD by architect
               8) Concealed low voltage LED end panel lights
               9) Fabric: Maharam, Divina by Kvadrat 460730 color 173
               10) Recessed row letters
               11) Recessed seat numbers
               12) Recessed donor tags
      2. See Appendix for basis of design example images.

E. Capacities:
   1. Seats:
a. Seats shall be tested and professionally certified through an independent testing laboratory to support and withstand an evenly distributed minimum of 600 lbs. static load located 3" back from the front of the seat without deflection.
b. Seats shall be tested and professionally certified through an independent testing laboratory to withstand 300,000 operating cycles without added lubrication, spring fatigue or measurable bearing wear.
c. Seats shall be tested and professionally certified through an independent testing laboratory to withstand, without failure, not less than 100,000 impacts of a 40 lb. sandbag dropped equally from heights of 6", 8", 10" and 12".
d. All up-stops and down-stops shall be completely concealed.

2. Backs:
   a. Backs shall withstand an evenly distributed front or rear load of 450 lbs.
   b. Backs shall be tested and professionally certified through an independent testing laboratory to withstand, without failure, not less than 40,000 alternating swinging impact cycles by each of 2 opposing 40 lb. sandbags. Sandbags shall be moved horizontally and equally through various distances of 6", 8", 10" and 12" at 35 cpm.

3. Arm rests:
   a. Armrests shall be tested and professionally certified through an independent testing laboratory to accept a 250 lb. sandbag placed at the front of the armrest with no deflection.
   b. The same test shall be performed on the rear of the armrest.

F. Acoustic Performance
   1. Seat bottoms shall not create high-frequency noise that may disrupt performances when allowed to spring to their upright position from their down position. The sound level of the seats in motion shall not exceed 30 dB(A) when measured 3 feet from the seat bottom using a precision sound level meter on the fast response setting.

G. Fire Performance Characteristics
   2. Padding: Provide new (prime manufacture) polyurethane foam with an average burn length not exceeding 8" and average flame time after removal of flame source not exceeding 15 seconds, with drippings from test specimen not continuing to flame for more than 5 seconds after falling, when tested vertically in compliance with Federal Test Method Standard 191, Method 5903.2.
   3. Fabric to comply with 16 CFR Part 1610 Class 1.

2.4 MATERIALS

A. General
   1. All equipment and components shall be new and complete. No used or reconditioned equipment shall be acceptable unless otherwise noted.
   2. All equipment to have pertinent testing labels.
   3. All variations from the specified materials and product must be approved by the Architect.

B. Materials shall conform to the following minimum standard specifications:
   3. Steel Sheets for Baked Enamel Finish: American Society of Testing Materials A591, commercial and drawing quality; Class C, galvanized-bonderized; 20 gauge minimum unless otherwise indicated.
4. Expansion Bolts: FS FF-B-588; Type, Class, and Style as recommended by the chair manufacturer.

C. Finishes
1. Finish for all exposed metal parts shall be selected by the Architect and shall match.
2. Finish for all exposed plastic parts shall be selected by the Architect and shall match.
3. Exposed Wood (including plywood): Manufacturer’s standard hardwood, free of visible defects. Color shall be stain per the Architect. Species shall be as specified. Seal with lacquer.
4. Fabric:
   a. Upholstery fabric shall be as specified.
   c. Light Fast: Exceeds 48 hour NAFM requirement. Test method A.A.T.C.C.-16A.
   d. The fabric shall be strengthened with an acrylic or similar backing.
5. Cushions: Seat and back cushions made of open cell polyurethane foam.
6. Fasteners: All fasteners shall be concealed. No exposed fasteners permitted.

2.5 UPHOLSTERED SEATS
A. The seat shall have seat pans constructed of steel and upholstered molded foam cushion, with a wood panel bottom.
B. The seat should be well shaped to provide maximum comfort.
C. Equip chairs with noiseless gravity uplift devices, so that unoccupied seats quietly rise to uniform full vertical fold.
D. Provide for seat rotation on bushings which do not require lubrication and have a positive internal return stop of rubber or neoprene.
E. The seats shall be free of exposed screws and bolts on the bottom, front and sides.

2.6 UPHOLSTERED BACKS
A. The seat back will be upholstered on the front with a wood panel on the rear.
B. The seat back will be ergonomically designed back with lumbar support.
C. Inner structure will be a rigid triple curved, molded, compressed fire-retardant chipboard.
D. Foam padding will be cold molded CMHR polyurethane foam.
E. The backs shall be free of screws and bolts on the bottom, front and sides.
F. The back of the rear panel shall not be upholstered nor covered with fabric of any kind.
   1. Wood type and stain will be chosen by the Architect from the manufacturer’s standard products.
2.7 AISLE AND INTERMEDIATE CHAIR STANDARDS

A. Standards shall be fabricated from tubular steel.
   1. Tubular Steel Standards: Fabricate chair standards of heavy gauge rectangular steel tubing securely welded to steel mounting plate, with seat, back and armrest connections welded to tubing.
      a. All weldments shall be gas shielded, arc welded.
   2. Fabricate standards, or provide adaptors if necessary, for attachment to floor conditions. Use products which have been manufactured to allow maximum cleaning space below point of attachment while maintaining seat level orientation and proper height above floor.
   3. Provide bolt caps at each floor standard foot which cover mounting stud and nut. Color to match selected metal finish for aisle standard.

2.8 AISLE END PANEL

A. The aisle end panel shall be a decorative panel as described above.

2.9 TRANSFER ARMS

A. Provide aisle standards equipped with swing-away end panel assemblies in locations shown on drawings and as required by building codes and the ADA.

B. The aisle end panel assembly shall swing away to allow the individual access to the seat. Aisle standards shall use positive latching hardware to secure swinging panel in place.

C. The accessible aisle end panels shall match others that are not accessible.

D. The accessible aisle end panels shall be designated with code complying graphics. All graphic elements shall be set flush in chair surfaces and shall be permanently affixed to the chair with dry adhesive.

2.10 ARMREST

A. Provide armrest at each aisle and between chairs, designed for concealed mounting to standards.

B. Armrests shall be of solid wood construction with exposed edges well rounded.

C. Armrests at aisle end standards accepting concealed light elements shall be wider than intermediate armrests and shall be routed or coped to accept concealed light assembly.

D. Attachment shall be with 2 keyhole slots plus 1 security screw, or countersunk fasteners on underside.

2.11 END PANEL LIGHTS

A. Provide integral end panel lights in locations as shown on the drawings.

B. End panel light shall be a low voltage LED luminaire that is recessed within the aisle end standard armrest.
C. End panel LED strip light fixture:
   1. Visual Lighting Technologies – Catalog #ELL-1QL-1720-30-AL-OP2, WE1-0-6"-UL, 130 lumens, .9w, 83CRI, remote dimming driver AC-PWR-PB-DMX1 (Type L103 specification section 26 52 01)

D. The end panel light on fixed chairs shall be pre-wired with No. 14 AWG wire with THHN type insulation, extending 24 inches beyond the end standard mounting foot. Provide a flex-steel conduit whip and fittings pre-attached to the interior of the end standard.
   1. Mounting of whip shall be tight to leg support/foot of aisle end standard, so as to be as unobtrusive as possible.
   2. Bright finishes of flex steel conduit shall be painted over with base color matching end standards to reduce visibility.

E. The end panel light on removable chairs shall be pre-wired with black S or SO neoprene covered cable with L1-15 locking plug, extending 24 inches beyond the chair mounting foot. Provide fittings pre-attached to standard.
   1. Plug shall mate with floor box receptacle provided by Division 26.

F. Provide low voltage DMX compatible transformers as required for installation under Division 26. Transformers shall be provided in quantities to allow for zoning of the aisle lights as shown on the drawings. Transformers shall be housed in a steel safety enclosure complete with primary and secondary fuses, terminal blocks and safety disconnect.
   1. End panel lighting and all associated power and transformers shall be inaudible under all operating conditions.
   2. Provide all necessary hardware for vibration isolation mounting. Mounting shall prevent vibration from being transmitted into the concrete slab. Assembly shall include:
      a. Unistrut, bolts, washers and nuts
      b. Mason Industries HLW multiple layer neoprene impregnated duck washers or equal.

G. Provide one LED DMX compatible dimming driver per transformer / zone allowing smooth full to zero percent dimming for all aisle end panel lights. Drivers installed under Division 26.

2.12 NUMBER AND LETTER PLATES

A. Provide seat number plates for seat location identification system corresponding to approved shop drawings.
   1. Plate type and finish to be manufacturer standard and shall be selected by the Architect.
   2. Font, color and text size information to be provided by the Architect.

B. Provide row letter plates mounted to aisle end standards for seat location identification system corresponding to approved shop drawings.
   1. Plate type and finish to manufacturer standard and shall be selected by the Architect.
   2. Font, color and text size information to be provided by the Architect.

C. Text fill shall be deep in color and consistent. Characters shall be centered on the plate.

D. Fixing shall be by two-part epoxy adhesive.

E. Number, letter plates located on wood finishes will be located in a recess resulting in an even flush surface across the wood finish and plate. Recesses will be identical in location, size and quality of workmanship.
2.13 MOVABLE CHAIR BASES

A. Designated chairs on the drawings shall be provided with low-profile steel platforms fitted with specially designed locking devices to provide for easy removal and re-attachment of the chair to accommodate conversion of the space for equipment access.

B. Release/transport tool shall be provided to the Owner with each chair/platform.

2.14 FABRICATION

A. Fabricate all work in this section in accordance with the Architect’s direction, specifications, approved shop drawings, pertinent project drawings, established trade practices, and applicable code requirements.

B. Machine finish all operating parts to standard trade tolerances, fits and finishes.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Contractor must examine areas and conditions under which auditorium seating is to be installed, including condition of substrate to which seating standards are to be attached, and must notify the Architect in writing of conditions detrimental to proper and timely completion of work. Work will not proceed until unsatisfactory conditions have been corrected in a manner acceptable to the Contractor.

B. Surface Preparation: Prepare all surfaces as to manufacturer’s recommendations. Comply with all industry standards regarding surface materials.

3.2 INSTALLATION

A. Install all work in this section in accordance with the Architect’s direction, specifications, approved shop drawings, pertinent project drawings, established trade practices and applicable code requirements.

B. Install all work securely, complete with all bolts, nuts, washers, clips, fittings, supports, and other items required for proper installation and operation.

C. Position all items accurately as indicated on drawings and true to plumb, line and level. Maintain maximum headroom and clearances at all points.

D. Install seats in locations indicated on approved shop drawings, with required clearances, elevations, and sightlines.

E. Install standards in locations necessitated by seating layout with each standard attached to the substrate by no less than two (2) anchoring devices of recommended size.

F. Install seats by mounting components to standards or brackets mounted on standards using industry approved hardware and fasteners.
G. Seats in back rows with a wall behind them or seats with a balustrade behind them should be set forward by 4”. Maintain aisle width.

H. Contractor shall ensure that mounting bolts and assembly hardware are cut and capped and/or otherwise finished to achieve both a finished appearance to the installation and eliminate protrusions and sharp edges which could cut and tear.

3.3 FIELD QUALITY CONTROL

A. The installation of the equipment indicated in this section shall be supervised by qualified personnel who are regularly employed by the Contractor for supervision of equipment installation similar to that indicated herein.

B. Installers must be appropriately skilled and experienced for the type and quality of work.

C. Arrange for all tests and inspections required by the General Requirements.

3.4 ADJUSTING

A. Adjust all equipment and components for operation in accordance with the specifications, approved shop drawings and pertinent project drawings prior to the demonstration indicated herein.

B. Verify that moving components operate smoothly and quietly.

C. Adjust seat uplift mechanisms to ensure that seats in each row are aligned when in upright position.

D. Replace any upholstery damaged during installation.

3.5 CLEANING

A. Touch-up minor abrasions and imperfections as required.

B. Remove from the premises all debris caused by this work. All unnecessary equipment and materials shall be removed from the area(s) of this work upon completion, removed from the job site and disposed of legally at no additional cost to the Owner.

3.6 CLOSEOUT ACTIVITIES

A. Demonstration
   1. Upon completion of the installation work required by the work of this Section, the Contractor will notify the Architect that the work is complete, conforms to specification and is ready for Demonstration.
   2. Installed equipment shall be operated for approval and inspected for quality by the Theatre Consultant, the Architect and the Owner.
   3. Installed seating shall be compared with the approved mock-up. They shall be identical in all respects.
   4. Adjustments or modifications shall be made as directed by the Architect and the Theatre Consultant.
5. Cost of re-inspection and additional testing by the Architect and Theatre Consultant, if required, due to lack of completion and/or errors and omissions shall be paid by the Contractor respective to the area of work concerned. This work will be conducted on a time and materials basis, including the Architect’s and Theatre Consultant’s standard hourly rates, and shall be scheduled and approved in writing prior to the re-inspection/testing session.

B. Training
   1. Following the equipment demonstration, inspection and final adjustments, the Owner’s designated staff or representatives shall be instructed in the use, care and maintenance of all items.
   2. Schedule the instruction in conformance with project construction schedule and the availability of the Owner.

3.7 PROTECTION
   A. Provide full protection from damage, construction dirt and debris for all equipment from the point of installation to testing and commissioning.
   B. Remove all equipment protection and clean all components thoroughly prior to the demonstration session.

3.8 ATTACHMENTS
   A. Refer to Appendix A of this section for basis of design illustrations

END OF SECTION 12 61 00
SECTION 134898
SOUND & VIBRATION CONTROL

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes: Manufactured components for sound and vibration isolation.
   1. Slab underlayment.
   2. Slab perimeter isolation.
   3. Ceiling hangers.
   4. Compact ceiling hangers.
   5. Partition sway braces.
B. Related Sections:
   1. Section 018122 - Facility Acoustic Performance Requirements:
   2. Sections 031100, 031500, 032000 and Section 033000: Isolated concrete slabs.
   3. Sections 054000, 092216 and 092900: Isolated gypsum board assemblies.

1.2 ACTION SUBMITTALS
A. Product Data: For each product.
B. Shop Drawings: Prepared by component manufacturer, include layout, section, and transition details, load conditions, isolator natural frequency and load deflection curves, and construction sequence.
C. Isolator Selection:
   1. Bearing surface area and spacing of each isolator shall be determined by Manufacturer based on final evaluation of concentrated and uniformly imposed loads.
   2. At load, isolator shall maintain uniform deflection of the floating floor.
D. Product Schedule:
   1. Component manufacturer and type.
   2. Deflection of each isolation element.
   3. Spring constant of each isolation element.
   4. Estimated imposed load on each isolation element.
   5. Spring o.d., free operating, and solid heights.
E. Isolated Floating Floor:
   1. Dead, live and concentrated loads.
   2. Isolator sizes, deflections, frequencies and locations.
   3. Any drains or other penetrations.
   4. Size, type, elevation and spacing of concrete reinforcement.
   5. Caulking details.
   6. Floating floor construction procedure.
F. Spring-Isolated Ceiling Assemblies:
   1. Indicate layout and location of each isolation hanger, location and direction of cold-rolled carrying channel.
   2. Include details of edge conditions where isolated ceiling construction meets or adjoins other construction.
   3. loads for all ceiling supported systems for incorporation in calculations of spring sizing
G. Isolated Partitions:
1. Load and deflection curves of all sway braces in both planes. Load and deflection curves of wall isolation pads. Detail drawings of angle braces.
2. Sway Brace Layout: Engineered by contractor in conjunction with steel stud framing.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service acoustical performance. Qualified firm will provide authorized technical representatives to observe and inspect installation of products, equipment and assemblies.

B. Installers Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, being familiar with special acoustical requirements indicated, and whose work has resulted in construction with a record of successful acoustical performance.

C. Preconstruction Conference: Prior to start of Work, conduct a conference to ensure understanding of Construction Documents and special acoustical requirements of acoustically-critical spaces and construction.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Products and Manufacturers: Subject to compliance with specified requirements, provide Basis of Design or equivalent product as approved by Architect, by one of the following Manufacturers:
1. ECORE International.
2. General Rubber Corporation.
3. Impacta-Regupol
4. Kinetics Noise Control, Inc..
5. Mason Industries.
6. Pliteq.
7. RPG, Inc..
8. The VMC Group.

2.2 ISOLATED SLABS

A. (SVC-3) Continuous Concrete Slab Isolation Underlayment: Single-ply, non-laminated, re-bonded recycled rubber underlayment with dimpled profile.
2. Basis of Design: Pliteq FF25

B. (SVC-5) Continuous Polystyrene Perimeter Isolation:
1. Flat Re-bonded recycled rubber perimeter isolation strip, 1/2-inch thick.
   a. Type PIS Perimeter Rubber Isolation Strip by Pliteq.
   a. GenieMat Polyethylene Foam Perimeter Isolation Strip by Pliteq.

C. Caulking Compound: Non-hardening, drying or bleeding. Troweling or pouring grade.
1. Basis of Design: Type CC-75 by Mason Industries, Inc..

D. Angle Brackets: 1-1/2” x 2” angle iron sections with provision for bolting to the structure and a minimum thickness of 3/8” sponge cemented to the vertical leg.
1. Basis of Design: Type AB-716 by Mason Industries.
E. Isolators: Bell shaped castings with integral lugs to locate reinforcing, shrouding 2"(50mm) thick LDS isolators molded to the following AASHO bridge bearing specifications. All housings shall have 3/4"(20mm) minimum diameter jackscrews. Deflections shall not exceed 0.3"(75mm) nor the frequency 10Hz.

1. Basis of Design: Type FSN by Mason Industries, Inc.

2.3 ISOLATED CEILINGS

A. Spring Hangers:
   1. Fail safe.
   2. AASHTO Quality and Dynamic Stiffness

B. (SVC-11) Ceiling Hangers: Combination Neoprene and Spring Hanger, consisting of a steel frame containing a neoprene isolation element at the top and a coil steel spring seated in a neoprene cup on the bottom.
   1. rubber bushing extending through the box to prevent metal to metal contact between the steel suspension rod and the frame.
   2. allow a 30° swing from side to side before rod contact.
   3. Springs shall be factory precompressed to 70% of the assigned deflection.
   4. Basis of Design: Type Mason Industries 30NCC for channel, W30N for wire, or W30NCC for wire and channel.
   5. Hangers shall be selected for a minimum of 0.75" (19mm) spring deflection and factory precompressed 70% of the total deflection determined by the assigned load per hanger.

C. (SVC-12) Ceiling Hanger, Compact: Low-profile, Combination Neoprene and Spring Hanger, compact spring and neoprene pad isolator hangers.
   1. Basis of Design:
      a. Type 30CSCH by Mason Industries.
      b. Type KSCH Super-Compact Ceiling Hanger by Kinetics Noise Control

2.4 ISOLATED PARTITIONS

A. (SVC-21) Continuous Isolation Strip and Bushings for Partition Headers and Sills: 30 or 40 durometer continuous strip, 1/2-inch thick and 6-inches wide; with resilient stabilizing bushing, steel washer and anchors.

B. (SVC-22) Sway Brace: Standard neoprene sway brace, 60 durometer neoprene.
   1. Basis of Design: Type DNSB Sway Brace by Mason Industries.

2.5 RESILIENT PADS

   1. Durometer: 40
   2. Thickness: 3/4-inch.
   3. Basis of Design: Super W Pads by Mason Industries

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which Work is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
B. Ensure concrete floors are dry and meet moisture conditions required by flooring and adhesive manufacturer’s (3 pounds per 1000 square feet based on ASTM F1869, calcium chloride test) and exhibit negative alkalinity, carbonization or dusting. Also ensure substrate meets requirements of adhesive and flooring manufacturer’s requirements. Remove curing agents and other surface residue that may negatively affect adhesion or flooring installation and performance.

3.2 INSTALLATION

A. All building components supported by the isolation hangers shall be free from rigid contact with any part of the non-isolated building structure to prevent unwanted sound flanking.

3.3 ISOLATED CONCRETE FLOOR

A. Division 03

B. The installation of all sound isolation materials specified herein, including those installed under other sections of the specifications shall be in accordance with procedure submitted by the isolation material manufacturer and approved by the Architect, Structural Engineer, and Acoustical Consultant.

C. Clean and prepare substrate in accordance with underlayment manufacturer’s instructions.

D. Lay mat seam to seam covering the area

E. Tape joints between rolls of the base mat and joints between base mat and perimeter isolation board to avoid leakage during concrete pour.

F. Perimeter Isolation:
   1. Install perimeter isolation strip from the top of the underlayment to a minimum of 1” above the scheduled thickness of the isolated concrete slab.
   2. Ensure a maximum gap between the perimeter isolation board and underlayment of 1/8”
   3. After concrete has cured, cut back excess perimeter isolation board and caulk perimeter.

G. Inspection: Notification shall be given by the Contractor to the Architect at the following stage. Architect approval shall be obtained prior to proceeding to the next stage of construction.
   1. Upon completion of all areas prior to the placement of isolation material.
   2. Upon completion of placement of isolation materials prior to installation of isolated concrete slab.
   3. Upon completion of installation of concrete pouring form and isolated, prior to start of concrete pour.
   4. Upon completion of concrete isolated slab.

3.4 SPRING-ISOLATED CEILING ASSEMBLIES

A. Prior to start of the installation of the isolated ceiling, adhesively apply a continuous strip of neoprene surface of perimeter partition; allow for deflection of isolators.

B. Lay on top of the gypsum board mineral wool in thickness as shown on the drawings.

C. After installation of isolated ceiling, cut exposed neoprene and caulk perimeter and all penetrations.

3.5 ISOLATED PARTITIONS

A. Bolt the sway braces to the structural wall as shown on approved Shop Drawings and use the leveling nuts to plumb the channels and set them in their vertical position.

B. Caulk all joints.
END OF SECTION
SECTION 142100

ELECTRIC TRACTION ELEVATORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Standard pre-engineered machine-roomless, electric traction elevators
   2. Passenger cab including cab doors
   3. Elevator car enclosures, hoistway entrances, frames and sills
   5. Motors, operation and control systems
   6. Accessibility provisions for physically disabled persons
   7. Equipment, machines, controls, systems and devices as required for safely operating the
      specified elevators at their rated speed and capacity.
   8. Materials and accessories as required to complete the elevator installation.

B. Related Sections:
   1. Division 5 Metals: Providing hoist beams, pit ladders, steel framing, auxiliary support steel and divider beams
      for supporting guide-rail brackets.
   2. Division 9 Finishes: Providing elevator car finish flooring and field painting unfinished and shop
      primed ferrous materials.
   3. Division 22 Plumbing:
   4. Division 23: Heating, Ventilation and Air Conditioning
   5. Division 26 Sections:
      a. Providing electrical service to elevators, including fused disconnect switches.
      b. Emergency power supply, transfer switch and auxiliary contacts.
      c. Heat and smoke sensing devices
      d. Convenience outlets and illumination in machine room, hoistway and pit

C. Work Not Included: General contractor shall provide the following in accordance with the
   requirements of the Model Building Code and ANSI A17.1 Code. For specific rules, refer to ANSI
   A17.1, Section 300 for hydraulic elevators. State or local requirements must be used if more
   stringent.
   1. Elevator hoist beam to be provided at top of elevator shaft. Beam must be able to accommodate
      proper loads and clearances for elevator installation and operation.
   2. Supply in ample time for installation by other trades, inserts, anchors, bearing plates, brackets,
      supports and bracing including all setting templates and diagrams for placement.
   3. Hatch walls require a minimum two hour fire rating. Hoistway should be clear and plumb with
      variations not to exceed 1/2” at any point.
   4. Elevator hoistways shall have barricades, as required.
   5. Install bevel guards at 75° on all recesses, projections or setbacks over 2” (4” for A17.1 2000
      areas) except for loading or unloading
   6. Provide rail bracket supports at pit, each floor and roof.
   7. Pit floor shall be level and free of debris. Reinforce dry pit to sustain normal vertical forces from
      rails and buffers.
   8. Where pit access is by means of the lowest hoistway entrance, a vertical ladder of non-
      combustible material extending 42” minimum, (48” minimum for A17.1-2000 areas) shall be
      provided at the same height, above sill of access door or handgrips.
9. Access to the machinery space must be in accordance with the governing authority or code.
10. Provide an 8” x 16” cutout through machine room wall, for oil line and wiring duct, coordinated with elevator contractor at the building site.
11. All wire and conduit should run remote from the hoistways.
12. When heat, smoke or combustion sensing devices are required, connect to elevator machine room terminals. Contacts on the sensors should be sided for 120 volt D.C.
13. Provide finished flooring in elevator cab.
14. Finished floors and entrance walls are not to be constructed until after sills and door frames are in place. Consult elevator contractor for rough opening size. The general contractor shall supply the drywall framing so that the wall fire resistance rating is maintained, when drywall construction is used.
15. Where sheet rock or drywall construction is used for front walls, it shall be of sufficient strength to maintain the doors in true lateral alignment. Drywall contractor to coordinate with elevator contractor.
16. Before erection of rough walls and doors; erect hoistway sills, headers, and frames. After rough walls are finished; erect fascias and toe guards. Set sill level and slightly above finished floor at landings.
17. The elevator wall shall interface with the hoistway entrance assembly and be in strict compliance with the elevator contractor's requirements.
18. Elevator sill supports shall be provided at each opening.
19. All walls and sill supports must be plumb where openings occur.
20. Locate a light fixture and convenience outlet in pit with switch located adjacent to the access door.
21. A light switch and fused disconnect switch for each elevator should be located inside the machine room adjacent to the door, where practical, per the National Electrical Code (NFPA No. 70).
22. As indicated by elevator contractor, provide a light outlet for each elevator, in center of hoistway.
23. For signal systems and power operated door: provide ground and branch wiring circuits, including main line switch. For car light and fan: provide a feeder and branch wiring circuits, including main line switch.
24. Wall thickness may increase when fixtures are mounted in drywall. These requirements must be coordinated between the general contractor and the elevator contractor.
25. Provide supports, patching and recesses to accommodate hall button boxes, signal fixtures, etc..
26. Locate telephone and convenience outlet on control panel.
27. Main line disconnects for each elevator.
   a. One fused three phase permanent power in building electrical distribution room
   b. One non fused three phase permanent power in hoist way at top landing
28. Hoistway ventilation shall be in accordance with local and national building code requirements.
29. Guide Rail Support shall be structurally adequate to extend from pit floor to top of hoistway, with spans in accordance with requirements of authority having jurisdiction and final layouts.
30. Lifeline attachments capable of withstanding 5000 lb load in accordance with OSHA 29 CFR 1926.502. Provide a minimum of 2 at the top, front of each hoistway.

1.2 REGULATORY REQUIREMENTS

A. Conform to:
   2. NSI A17.1b - Supplement to Safety Code for Elevators and Escalators.
   4. ANSI A17.2 - Practice for Inspection of Elevators, Escalators, and Moving Walks.
   5. American Disability Act (ADA).

B. Welding: AWS D1.1.
1.3 ACTION SUBMITTALS

A. Product data: Submit manufacturer’s product data for each system proposed for use. Include the following:
   1. Signal and operating fixtures, operating panels and indicators.
   2. Cab design, dimensions and layout.
   3. Hoistway-door and frame details.
   4. Electrical characteristics and connection requirements.
   5. Expected heat dissipation of elevator equipment in hoistway (BTU).
   6. Color selection chart for Cab and Entrances.

B. Shop Drawings: Submit in accordance with Division 1.
   1. Clearly indicate space requirements, general arrangement of elevator equipment, and material being supplied. Show connections, attachments, reinforcing, anchorage and location of exposed fastenings, and location and amount of loads and reactions to be carried on building structure.
   2. Provide plans, elevations, sections and details of assembly, erection, anchorage, and equipment location.
   3. Show equipment arrangement in the control space, pit and hoistway.
   4. Show floors served, travel distances, maximum loads imposed on the building structure at points of support and all similar considerations of the elevator work.
   5. Submit descriptive brochures or detail drawings of landing buttons, hall fixtures, car position indicators and car operating panels, car interior and hoistway doors and frames for review.
   6. Indicate electrical power requirements and branch circuit protection device recommendations.

C. Samples: Submit in accordance with Division 1.
   1. Submit samples of finishes and materials required for cars, operating and signal system fixtures and finish of hoistway entrances and doors.
   3. Plastic laminate selection: Submit sample as verification of match to PLAM specified in Elevator Schedule at end of this Section.
   4. Metal Finishes: Provide samples of standard specified metal finishes.

D. Prior to seeking final acceptance for the completed project as specified by the Contract Documents, the Elevator Contractor shall deliver to the Owner any specialized tool(s) that may be required to perform diagnostic evaluations, adjustments, and/or parametric software changes and/or test and inspections on any piece of control or monitoring equipment installed. This shall include any specialized tool(s) required for monitoring, inspection and/or maintenance where the means of suspension other than conventional wire ropes are furnished and installed by the Elevator Contractor. Any and all such tool(s) shall become property of the Owner. Any diagnostic tool provided to the Owner by the Elevator Contractor shall be configured to perform all levels of diagnostics, systems adjustment and parametric software changes which are available to the Elevator Contractor. In those cases where diagnostic tools provided to the Owner require periodic recalibration/or re-initiation, the Elevator Contractor shall perform such tasks at no additional cost to the Owner for a period equal to the term of the maintenance agreement from the date of final acceptance of the completed project. During those intervals in which the Owner might find it necessary to surrender a diagnostic tool for re-calibration, re-initiation, or repair, the Elevator Contractor shall provide a temporary replacement for the tool at no additional cost to the Owner. The Elevator Contractor shall deliver to the Owner, printed instructions for the proper use of any tool that may be necessary to perform diagnostic evaluations, system adjustment, and/or parametric software changes on any unit of microprocessor-based elevator control equipment and means of suspension other than standard elevator steel cables furnished and install by the Elevator Contractor. Accompanying the printed instructions shall be any and all access codes, password, or other proprietary information that is necessary to interface with the microprocessor-control equipment.
1.4 INFORMATIONAL SUBMITTALS
A. Operation and Maintenance Manuals: Include operations and maintenance instructions, parts listing with sources indicated, recommended parts inventory listing, emergency instructions, and similar information. Include diagnostic and repair information available to manufacturer's and installer's maintenance personnel.
   1. Owner's Manual and Wiring Diagrams
   2. Parts list, with recommended parts inventory.
B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: An approved manufacturer with minimum fifteen years experience in manufacturing, installing, and servicing elevators of the type required for the project.
   1. Must be the manufacturer of the power unit, controller, signal fixtures, door operators cab, entrances, and all other major parts of the elevator operating equipment.
      a. The major parts of the elevator equipment shall be manufactured in the United States, and not be an assembled system.
   2. The manufacturer shall have a documented, on-going quality assurance program.
   3. ISO-9001:2000 Manufacturer Certified
   4. ISO-14001:2004 Environmental Management System Certified
B. Installer Qualifications: Elevator manufacturer or experienced installer approved by elevator manufacturer who has completed elevator installations similar in material, design, and extent to that indicated for this Project and with fifteen-year record of successful in-service performance.
C. Fire-rated Entrance Assemblies: Opening protective assemblies including frames, hardware, and operation shall comply with ASTM E2074, (ULC-S104), UL10(B), and NFPA 80. Provide entrance assembly units bearing Class B or 1 1/2 hour label by a Nationally Recognized Testing Laboratory.
D. Inspection and testing: Elevator Installer shall obtain and pay for all required inspections, tests, permits and fees for elevator installation.
   1. Arrange for inspections and make required tests.
   2. Deliver to the Owner upon completion and acceptance of elevator work.
E. Product Qualifications:
   1. LCA, EPD and HPD data must be provided for all major components of the elevator system.
   2. LCA data must be compatible with GaBI Software.
   3. Environmental Product Declaration (EPD): Publicly available, critically reviewed life cycle analysis having at least a cradle-to-gate scope.
   4. GreenScreen Chemical Hazard Analysis: All ingredients of 100 parts-per-million or greater evaluated using GreenScreen for Safer Chemicals Method v1.2.
   5. Health Product Declarations (HPD v2 or later): Complete, published declaration with full disclosure of known hazards, prepared using the Health Product Declaration Collaborative's "HPD builder" on-line tool; Unknown hazard listed will not be considered acceptable.

1.6 DELIVERY, STORAGE AND HANDLING
A. Deliver items or materials to site until area in which they are to be installed is ready to receive them in their place of final installation.
B. Store materials in storage area allotted and in such manner as to prevent deterioration, damage, or loss of their essential properties.
C. Fully protect movable and operating equipment from weather.
D. Wrap and crate factory finished materials in manner to protect their finishes.
1.7 PROJECT CONDITIONS
A. Prohibited Use: Elevators shall not be used for temporary service or for any other purpose during the construction period before Substantial Completion and acceptance by the purchaser unless agreed upon by Elevator Contractor and General Contractor with signed temporary agreement.

1.8 POWER CHARACTERISTICS
A. Elevator Apparatus: Volt as indicated by Electrical, phase as required, 60 Hz alternating current.
B. Lighting: 120 volt, 60 Hz alternating current.

1.9 WARRANTY
A. Provide manufacturer warranty for a period of one year after completion of installation or acceptance thereof by beneficial use, whichever is earlier. The warranty period is to begin upon Substantial Completion of the Contract. Warranty covers defects in materials and workmanship not due to ordinary wear and tear or improper use or care. Damage due to ordinary use, vandalism, improper or insufficient maintenance, misuse, or neglect do not constitute defective material or workmanship.

1.10 MAINTENANCE
A. Maintain entire elevator installation for 12 months after date of Substantial Completion of Work.
B. Include systematic examination, adjustment and lubrication of elevator equipment, repair or replace worn electrical and mechanical parts of elevator equipment using only genuine standard parts produced by manufacturer of equipment concerned to keep the elevator in proper operation.
C. Replace seals, packing, and valves to maintain required factor of safety.
D. Perform work without removing cars during peak traffic periods.
E. Provide 24 hour emergency call back service during maintenance period.
F. Ensure that competent personnel handle maintenance service. Maintain locally adequate stock of parts for replacement or emergency purposes and have qualified personnel available at such places to ensure fulfillment of this service without unreasonable loss of time.
G. Provide system capabilities to enable a remote expert to create a live, interactive connection with the elevator system to enable the following functions:
   1. Remotely diagnose elevator issues with a remote team of experts
   2. Remotely return an elevator to service
   3. Provide real-time status updates via email
   4. Remotely make changes to selected elevator functions including:
      a. Control building traffic: Restrict floor access, remove car from group operation, shut down elevator, select up peak / down peak mode, activate independent service
      b. Conserve energy: Activate cab light energy save mode, activate fan energy save mode, shut down car(s)
      c. Improve passenger experience: Extend door open times, change parking floor, activate auto car full, activate anti-nuisance, advance door opening, door nudging, extend specific floor extended opening time, release trapped passengers

1.11 MAINTENANCE PROPOSAL
A. Proposal for maintenance of installed elevator work for period of 3 years after termination of regular maintenance as required in preceding article.
B. Proposal shall include stipulated sum for above stated time period with premiums due annually.
C. Maintenance shall include requirements stated in preceding article.
PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Source Limitations: Obtain elevators from single manufacturer.
   1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

B. Car Performance
   1. Car Speed ± 5% of contract speed under any loading condition or direction of travel.
   2. Car Capacity: Safely lower, stop and hold (per code) up to 125% of rated load.

C. System Performance
   1. Vertical Vibration (maximum): 15 mg ISO187338/ISO 8041 system pk -pk
   2. Horizontal Vibration (maximum): 12 mg ISO187338/ISO 8041 system pk -pk
   3. Jerk Rate (maximum): 3.3 ft/sec3
   4. Acceleration (maximum) 1.3 ft/sec2
   5. In Car Noise: = 55 dB(A)
   6. Leveling Accuracy: ±0.2 inches
   7. Starts per hour (maximum): 180

2.2 MATERIALS AND COMPONENTS

A. Rolled Steel Sections, Shapes, Rods: ANSI A17.1.

B. Sheet Steel: ASTM A446, G90 coating designation, stretcher levelled commercial grade.

C. Stainless Steel: ASTM A167, Type 302/304, No. 4 finish.

D. Plywood: PS 1, Western Softwood; (Douglas Fir) good one side, fire retardant treated per following requirements:
   1. Each piece to bear:
      a. UL FR-S rating (flame spread and smoke developed less than 25),
      b. Complying with extended 30-minute tunnel test, ASTM E84 or UL 723
      c. Meet interior Type A requirements in AWPA Standard C-27 for plywood.
      d. And shall be registered for use as a wood preservative by the U.S. Environmental Protection Agency.
   2. Treatment to provide protection against:
      a. Termites.
      b. Fungal decay.
   3. Treatment to be free of:
      a. Hologens.
      b. Sulfates.
      c. Ammonium phosphate.
      d. Formaldehyde.
   4. After treatment: Material shall be dried to an average moisture content of 15 percent or less for plywood and 19 percent or less for other lumber.
   5. Coat surfaces cut after treatment with heavy brush coat of same fire-retardant chemical

6. Manufacturers:
   a. Dricon by Arch Wood Products.
   b. Pyro-Guard by Hoover Treated Wood Products.

E. Plastic Laminate: FS L-P-508; color, texture and pattern selected by Architect.

2.3 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. KONE Inc. (Basis of Design)
2. Otis Elevator Co.
3. Schindler Elevator Corp.
5. Substitutions: Allowed in accordance with the requirements of Division 1.

2.4 ELECTRIC TRACTION ELEVATORS

A. (ELEV-1) Electric Gearless Traction Elevator:
2. Rated Capacity: 2000 lb
3. Rated Speed: 150 fpm minimum
4. Equipment Control: KCM831
5. Drive: Non-Regenerative
6. Quantity of Elevators: 1
7. Landings: 3
8. Openings: 3 Front Openings, 0 Back Openings
9. Travel: 29' 3" nominal (refer to Drawings)
10. Clear Inside Dimensions (W x D): 5' 9" x 4' 4"
11. Cab Height: 8' 0"
12. Clear height under suspended ceiling: 7' 6"
13. Entrance Width and Type: 3' 0" and Left Opening
14. Entrance Height: 7' 0"
15. Main Power Supply: 208 Volts + 5%, three-phase
16. Operation: Simplex
17. Machine Location: Inside the hoistway mounted on car guide rail
18. Control Space Location: Machine-roomless
19. Elevator Equipment shall conform to the requirements of seismic zone: non-seismic
20. Controller: Provide microcomputer based control system to perform all of the functions.
   a. All high voltage (110V or above) contact points inside the controller cabinet shall be protected from accidental contact in a situation where the controller doors are open.
   b. Controller shall be separated into two distinct halves; Motor Drive side and Control side. High voltage motor power conductors shall be routed and physically segregated from the rest of the controller.
   c. Provide a serial cardrack and main CPU board containing a non-erasable EPROM and operating system firmware.
   d. Variable field parameters and adjustments shall be contained in a non-volatile memory module.
21. Drive: Provide Variable Voltage Variable Frequency AC drive system to develop high starting torque with low starting current.
23. Emergency Operation: Connect to existing emergency power
24. Provide keyed control access (only) to basement level

B. (ELEV-4) Electric Gearless Traction Elevator:
2. Rated Capacity: 5000 lb
3. Rated Speed: 150 fpm minimum
4. Equipment Control: KCM831
5. Drive: Non-Regenerative
6. Quantity of Elevators: 1
7. Landings: 3
8. Openings: 3 Front Openings, 0 Back Openings
9. Travel: 28' 0" nominal (refer to Drawings)
10. Clear Inside Dimensions (W x D): 5' 9" x 9' 0"
11. Cab Height: 9' 0"
12. Clear height under suspended ceiling: 8' 6"
13. Entrance Width and Type: 3' 0" and Left Opening  
14. Entrance Height: 7' 0"
15. Main Power Supply: 208 Volts + 5%, three-phase
16. Operation: Simplex  
17. Machine Location: Inside the hoistway mounted on car guide rail  
18. Control Space Location: Machine-roomless
19. Elevator Equipment shall conform to the requirements of seismic zone: non-seismic
20. Controller: Provide microcomputer based control system to perform all of the functions.  
   a. All high voltage (110V or above) contact points inside the controller cabinet shall be protected from accidental contact in a situation where the controller doors are open.
   b. Controller shall be separated into two distinct halves; Motor Drive side and Control side. High voltage motor power conductors shall be routed and physically segregated from the rest of the controller.
   c. Provide a serial cardrack and main CPU board containing a non-erasable EPROM and operating system firmware.
   d. Variable field parameters and adjustments shall be contained in a non-volatile memory module.
21. Drive: Provide Variable Voltage Variable Frequency AC drive system to develop high starting torque with low starting current.
23. Emergency Operation: Connect to existing emergency power

C. Equipment and Controls:

1. Equipment Hoistway Components:
   a. Machine: AC gearless machine, with permanent magnet synchronous motor, direct current electro-mechanical disc brakes and integral traction drive sheave, mounted to the car guide rail at the top of the hoistway.
   b. Governor: Friction type over-speed governor rated for the duty of the elevator specified.
   d. Hoistway Operating Devices:
      1) Emergency stop switch in the pit  
      2) Terminal stopping switches.
      3) Emergency stop switch on the machine
   e. Positioning System: System consisting of magnets and proximity switches.
   f. Guide Rails and Attachments: Steel rails with brackets and fasteners.
2. Equipment Hoistway Entrances:
   a. Hoistway Entrances
      1) Sills: Aluminum extruded.
      2) Doors: Hollow metal construction with vertical internal channel reinforcements.
      3) Fire Rating: Entrance and doors shall be UL fire-rated for 1-1/2 hour.
      4) Entrance Finish: Brushed Stainless Steel.
      5) Entrance Markings Jamb Plates: Provide standard entrance jamb tactile markings on both jambs, at all floors. Plate Mounting: Refer to manufacturer drawings.
3. Equipment Car Components:
   a. Car Frame: Provide car frame with adequate bracing to support the platform and car enclosure.
   b. Platform: Platform shall be all steel construction.
   c. Car Guides: Provide guide-shoes mounted to top and bottom of both car and counterweight frame. Each guide-shoe assembly shall be arranged to maintain constant contact on the rail surfaces. Provide retainers in areas with Seismic design requirements.
   d. Steel Cab Cool Vintage Standard - 42009
   e. Car Wall Finish:
      1) Rear Wall: Non-removable vertical panels Graphic Bamboo printed laminate.
      2) Side Walls: Non-removable vertical panels Pearl Silver laminate.
   f. Car Skirting Finish: Brushed Stainless Steel
   g. Car Front Finish: Brushed Stainless Steel
h. Car Door Finish: Brushed Stainless Steel
i. Ceiling: Rectangular LED light panel, Brushed Stainless Steel
j. Handrail: Round, straight ends, Brushed Stainless Steel
   1) Rails to be located on Side Walls of car enclosure.
k. Threshold: Aluminum
l. Flooring: By others. (Not to exceed 6lb/sqft and 1/2” finished depth.)
m. Emergency Car Signals
   1) Emergency Siren: Siren mounted on top of cab that is activated when the alarm button in the car operating panel is engaged. Siren shall have rated sound pressure level of 80 dB(A) at a distance of three feet from device. Siren shall respond with a delay of not more than one second after activation of alarm button.
   2) Emergency Car Lighting: Provide connection to existing emergency power to maintain elevator operation and to illuminate the elevator car and provide current to the alarm bell in the event of building power failure.
   3) Emergency Exit Contact: An electrical contact shall be provided on the car-top exit.
n. Ventilation: Fan

4. Equipment Signal Devices and Fixtures:
   a. Car Operating Panel: Provide car operating panel with all push buttons, key switches, and message indicators for elevator operation. Fixture finish to be: Brushed Stainless Steel
      1) Main Flush mounted car operating panel shall contain a bank of round, mechanical, illuminated buttons marked to correspond to landings served, emergency call button, door open button, door close button, and key switches for lights, inspection, and exhaust fan. Buttons have Amber illumination (halo). All buttons to have raised text and Braille marking on left hand side. The car operating display panel shall be Amber DOT-matrix. All texts, when illuminated, shall be Amber. The car operating panel shall have a Brushed Stainless Steel finish.
      2) Additional features of car operating panel shall include:
         (a) Car Position Indicator within operating panel (Amber).
         (b) Elevator Data Plate marked with elevator capacity and car number on car top.
         (c) Help buttons with raised markings.
         (d) In car stop switch per local code.
         (e) Call Cancel Button.

   b. Hall Fixtures: Wall mounted hall fixtures shall be provided with necessary push buttons and key switches for elevator operation. Wall mounted hall fixtures shall have a Brushed Stainless Steel.
      1) Hall fixtures shall feature round, mechanical, buttons in applied mount face frame. Hall fixtures shall correspond to options available from that landing. Buttons shall be in a vertically mounted fixture. Hall fixtures shall not be jambmounted. Hall lanterns shall feature Amber illumination.
   c. Car Lantern and Chime: A directional lantern visible from the corridor shall be provided in the car entrance. When the car stops and the doors are opening, the lantern shall indicate the direction in which the car is to travel and a chime will sound. The chime will sound once for up and twice for down. The car riding lantern face plate shall have a Brushed Stainless Steel finish

5. Equipment Elevator Operation and Controller
   a. Elevator Operation
      1) Simplex Collective Operation: Using a microprocessor-based controller, operation shall be automatic by means of the car and hall buttons. If all calls in the system have been answered, the car shall park at the last landing served.
      2) Zoned Car Parking.
      3) Relative System Response Dispatching.
   b. Standard Operating Features to include:
      1) Full Collective Operation
      2) Fan and Light Control.
      3) Load Weighing Bypass.
4) Ascending Car Uncontrolled Movement Protection
5) Top of Car Inspection Station.

c. Additional Operating Features to include:
d. Elevator Control System for Inspections and Emergency
   1) Provide devices within controller to run the elevator in inspection operation.
   2) Provide devices on car top to run the elevator in inspection operation.
   3) Provide within controller an emergency stop switch to disconnect power from the brake and prevents motor from running.
   4) Provide the means from the controller to mechanically lift and control the elevator brake to safely bring car to nearest available landing when power is interrupted.
   5) Provide the means from the controller to reset the governor over speed switch and also trip the governor.
   6) Provide the means from the controller to reset the emergency brake when set because of an unintended car movement or ascending car over speed.
   7) Provide the means for the control to reset elevator earthquake operation.

6. Equipment Door Operator and Control:
a. Door Operator: A closed loop permanent magnet VVVF high-performance door operator shall be provided to open and close the car and hoistway doors simultaneously. Door movement shall be cushioned at both limits of travel. Electro-mechanical interlock shall be provided at each hoistway entrance to prevent operation of the elevator unless all doors are closed and locked. An electric contact shall be provided on the car at each car entrance to prevent the operation of the elevator unless the car door is closed.
b. The door operator shall be arranged so that, in case of interruption or failure of electric power, the doors can be readily opened by hand from within the car, in accordance with applicable code. Emergency devices and keys for opening doors from the landing shall be provided as required by local code.
c. Doors shall open automatically when the car has arrived at or is leveling at the respective landings. Doors shall close after a predetermined time interval or immediately upon pressing of a car button. A door open button shall be provided in the car. Momentary pressing of this button shall reopen the doors and reset the time interval.
d. Door hangers and tracks shall be provided for each car and hoistway door. Tracks shall be contoured to match the hanger sheaves. The hangers shall be designed for power operation with provisions for vertical and lateral adjustment. Hanger sheaves shall have polyurethane tires and pre-lubricated sealed-for-life bearings.
e. Electronic Door Safety Device. The elevator car shall be equipped with an electronic protective device extending the full height of the car. When activated, this sensor shall prevent the doors from closing or cause them to stop and reopen if they are in the process of closing. The doors shall remain open as long as the flow of traffic continues and shall close shortly after the last person passes through the door opening.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Examine work of other trades on which work of this Section depends. Report defects to Architect in writing which may affect Work of this trade or equipment operation. Do not proceed with elevator installation until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

B. Ensure that shafts and openings for moving equipment are plumb, level and in line and that pit is to proper depth, waterproofed and drained with necessary access doors, cylinder opening, ladder, guard and verify all critical dimensions.

C. Before fabrication, take necessary job site measurements and verify where work is governed by other trades. Check measurements of space for equipment and means of access for installation and operation. Obtain dimensions from site for preparation of shop drawings.
D. Ensure following preparatory work, provided under other Sections has been properly completed to receive elevator work:
   1. Supply of electric feeder wires to terminals of elevator control panel, including fused main line switch or circuit breaker. Provision of hoistway outlets for car light, and for light and outlets in pit. Furnishing of electric power for testing and adjusting elevator equipment
   2. Provision of hoistway outlet for telephone
   3. Supply of power for emergency cab lighting and ventilation from power panel specified in Division 26 Electrical fed by building emergency circuits

E. Supply in ample time for installation, inserts, anchors, pipe sleeves, bearing plates, brackets, supports and bracing including setting templates and diagrams for placement.

F. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.

3.2 PREPARATION
A. Coordinate installation of anchors, bearing plates, brackets and other related accessories.

3.3 INSTALLATION
A. Install elevator systems components and coordinate installation of hoistway wall construction.
   1. Work shall be performed by manufacturer-approved competent elevator installation personnel in accordance with ASME A17.1, manufacturer's installation instructions and approved shop drawings and under direct control and supervision of elevator manufacturer's experienced foreman
   2. Comply with the National Electrical Code for electrical work required during installation.
B. Coordination: Coordinate elevator work with the work of other trades, for proper time and sequence to avoid construction delays. Use benchmarks, lines, and levels designated by the Contractor, to ensure dimensional coordination of the work.
   1. Coordinate emergency power transfer switch and power change pending signals as required for termination at the primary elevator signal control cabinet in each group
C. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with cars. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum safe, workable dimensions at each landing.
D. Install machinery, guides, controls, car and equipment and accessories in accordance with manufacturer's instructions, applicable codes, and standards to provide quiet, smoothly operating installation, free from sidesway, oscillation, or vibration.
E. Install and hookup piping between machine and cylinder.
F. Erect hoistway sills, headers and frames prior to erection of rough walls and doors; erect fascias and toe guards after rough walls finished.
G. Grout sills and hoistway entrance doors.
H. Provide stainless steel license holders in each elevator car to suit certificate issued. Design holder with nonvisible tamperproof fastenings.
I. Provide wall hooks and protective mats for walls of elevator car
J. Locate hall buttons and indicators as detailed on drawings
K. Lubricate operating parts of system where recommended by manufacturer.
### 3.4 FIELD QUALITY CONTROL

A. **Acceptance testing:** Upon completion of the elevator installation and before permitting use of elevator, perform acceptance tests as required by A17.1 Code and local authorities having jurisdiction. Perform other tests, if any, as required by governing regulations or agencies.
   1. Obtain and pay for inspections and permits and make such tests as are required by regulations of authorities. Make tests in presence of Architect.
   2. Final inspection shall be after elevator installation and hoisting enclosure are complete.

B. Advise Owner, Contractor, Architect, and governing authorities in advance of dates and times tests are to be performed on the elevator.

C. Deliver test certificates and permits to Architect.

### 3.5 ADJUST AND BALANCE

A. Make necessary adjustments of equipment to ensure elevator operates smoothly and accurately.

### 3.6 CLEANING

A. Before final acceptance, remove protection from finished surfaces and clean and polish surfaces in accordance with manufacturer's recommendations for type of material and finish provided. Stainless stall shall be cleaned with soap and water and dried with a non-abrasive surface; shall not be cleaned with bleached-based cleansers.

B. At completion of elevator work, remove tools, equipment, and surplus materials from site. Clean equipment rooms and hoistway. Remove trash and debris.  
   1. Use environmentally preferable and low VOC emitting cleaners for each application type. Cleaners that contain solvents, pine and/or citrus oils are not permitted.

### 3.7 PROTECTION

A. Locate and protect moveable equipment and controls in such way that they can only be operated by authorized persons.

B. At time of Substantial Completion of elevator work, or portion thereof, provide suitable protective coverings, barriers, devices, signs, or other such methods or procedures to protect elevator work from damage or deterioration. Maintain protective measures throughout remainder of construction period.

### 3.8 INSTRUCTION AND MAINTENANCE

A. Instruct Owner's personnel in proper use, operation and daily maintenance of elevators. Review emergency provisions, including emergency access and procedures to be followed at time of failure in operation and other building emergencies. Train Owner's personnel in normal procedures to be followed in checking for sources of operational failures or malfunctions. Confer with Owner on requirements for complete elevator maintenance program.

B. Make final check of each elevator operation, with Owner's personnel present and just prior to date of substantial completion. Determine that control systems and operating devices are functioning properly.

**END OF SECTION**
SECTION 142600 LIMITED-USE/LIMITED-APPLICATION ELEVATORS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Limited-use/limited-application (LU/LA) elevators (LIFT-3).
B. Related Sections:
   1. Section 142100 – Electric Traction Elevators.
   2. Section 144200 – Wheelchair Lifts
   3. Division 26: Electrical service to lift equipment.

1.2 DEFINITIONS
A. Definitions in ASME A17.1/CSA B44 apply to Work of this Section.
B. LU/LA: Limited use/limited application.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components, and finishes for lifts.
   2. Include rated capacities, operating characteristics, electrical characteristics, safety features, controls, finishes, and accessories.
B. Shop Drawings: For each lift.
   1. Include plans, elevations, sections, details, attachments to other work, and required clearances.
   2. Indicate dimensions, weights, loads, and points of load to building structure.
   3. Include details of equipment assemblies, method of field assembly, components, and location and size of each field connection.
   4. Include diagrams for power, signal, and control wiring.
C. Samples: Submit samples of side panels for color and appearance acceptance.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer.
B. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator being provided.
C. Preinstallation Examination Report: Indicating dimensional discrepancies and conditions detrimental to performance or indicating that dimensions and conditions were found to be satisfactory.
D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
   1. Submit manufacturer's/installer's standard operation and maintenance manual, according to ASME A17.1.
B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction, for normal, unrestricted elevator use.
C. Continuing Maintenance Proposal: Provide a continuing maintenance proposal from Installer to Owner, in the form of a standard five-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.8 COORDINATION
A. Examine supporting structure and conditions under which lift is to be installed, and notify Contractor in writing of conditions detrimental to proper and timely completion of work.
B. Coordinate installation of sleeves, block outs, and items that are embedded in concrete or masonry for elevator equipment. Furnish templates and installation instructions and deliver to Project site in time for installation.
C. Coordinate locations and dimensions of other work relating to LU/LA elevators including sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.9 WARRANTY
A. Warranty: Provide a two year limited warranty for wheelchair lift materials and workmanship.
B. Extended Warranty: Provide an extended manufacturer's warranty covering the wheelchair lift materials and workmanship for the following additional extended period beyond the initial two year warranty. Preventive Maintenance Agreement required
  1. Five Years (7 years total)

1.10 MAINTENANCE SERVICE
A. Initial Maintenance Service: Beginning at Substantial Completion, provide one year's full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
  1. Perform maintenance, including emergency callback service, during normal working hours.
  2. Include 24-hour-per-day, 7-day-per-week emergency callback service.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS
A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

2.2 MANUFACTURERS
A. Manufacturers: Subject to compliance with specified requirements, provide Basis of Design or equivalent product by one of the following Manufacturers, and as approved by Architect:
1. Garaventa Lift (Basis of Design)
2. Symmetry Elevator - Custom Hydraulic Drive LU/LA Elevator
3. Arrow Lift
4. Substitutions: Allowed in accordance with the requirements of Division 1

2.3 HYDRAULIC LU/LA ELEVATOR

A. (LIFT-2) LU/LA Elevator:
1. Basis of Design: Garaventa Lift, Elvoron LU/LA Hydraulic Elevator, Model 1L; 1,400 pounds (635 kg) capacity cable hydraulic elevator.
2. Capacity: 1,400 pounds (635 kg).
3. Car Size: Maximum of 18 SF (1.67 sm).
   a. Style 1L: 48 inches by 54 inches (1220 by 1372 mm) with one side right sliding doors.
4. Travel:
   a. 258 inches unless indicated otherwise on Drawings.
5. Stops:
   a. 3 stops.
6. Speed: Nominal 30 feet per minute (0.15 m/sec).
7. Pit Depth: Minimum 14 inches (355 mm) required.
8. Overhead: Total overhead clearance (Refuge Space) 135 inches (3330 mm) above the finished upper landing floor. This space allowance can be reduced to 114" (2896 mm) with the use of a car top prop.
9. Drive System: 1:2 Cable Hydraulic, Heavy Duty car sling with roller guide shoes running on 8 lb. per foot steel T-rails, Quiet submersed pump and motor, factory pre-set and tested 2-speed valve for smooth start and stop.
10. Power Requirements:
    a. 208 VAC three phase
    b. 110 VAC single phase, 15 amps (for lighting)
11. Controls:
    a. PLC Controller with integrated self diagnostics.
    b. Fully automatic push button at car and landings with Braille markings.
    c. Automatic car light switch upon entry.
    d. Digital floor indicator in Car.
    e. Car arrival lanterns in car door jamb.
    f. Arrival Gong
12. Car and Hoistway Doors: Nominal 36 inch by 80 inch (914 by 2032 mm) two-speed horizontal sliding hoistway and car doors.
13. Safety Features:
    a. Emergency back-up power with a manual lowering device.
       1) Connect to existing emergency power
    b. Safety brake system.
    c. Car operator with integral gate switch.
    d. Automatic bi-directional floor leveling.
    e. Emergency alarm button in car, Emergency keyed stop switch in car.
    f. Overspeed valve.
    g. Final limit switch.
    h. Low oil protection timer circuit.
14. Standard Features:
    a. Car direction lantern comes with audio and visual signals.
    b. Full height photo-electric door sensors.
    c. Automatic home park feature (can be disengaged during installation if desired).
15. Options:
    a. Integrated hands free telephone.
16. Machine Location:
    a. As indicated on the Drawings.
17. Cab Design:
a. Interior Walls: Laminate panel sections.
   1) As selected by Architect from manufacturer’s standards
b. Cab Frame:
   1) Mild steel powder coated in a custom color as selected by the Architect.
c. Ceiling Finish:
   1) Stainless Steel, brushed finish.
d. Handrail Finish:
   1) Stainless Steel, brushed finish.
e. Car Operating Panel Finish:
   1) Stainless Steel, brushed finish.
f. Floor: Unfinished plywood for final finish by others (as indicated)
g. Lighting: Four recessed L.E.D. down lights.
   1) Black Trim.
h. Car Direction Lantern: Car direction lantern complete with auto and visual signaling device indicating direction of travel and arrival at selected floor.
i. Car Doors: When open the doors provide a 36 inch (915 mm) by 80 inch (2032 mm) clear opening.
   1) Two Speed Horizontal Sliding equipped with full height photo-electric door sensors, color as follows:
      (a) Stainless steel, brushed finish.

18. Hoistway Entrances:
   a. Hoistway Entrances: When open the doors provide a 36 inch (915 mm) by 80 inch (2032 mm) clear opening.
      1) Two Speed Horizontal doors, finish as follows:
         (a) Stainless Steel, brushed finish.
   b. Hall Call Stations:
      1) Hall Station Type:
         (a) Keyless Push Button.
      2) Finish:
         (a) Stainless Steel, brushed finish.

B. Emergency Communication System: Provide system that complies with ASME A17.1 and the U.S. Architectural & Transportation Barriers Compliance Board’s "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." On activation, system dials preprogrammed number of monitoring station and identifies elevator location to monitoring station. System indicates when it has been activated and when monitoring station has responded. System provides for two-way communication, by both voice and visual display, together with push buttons. System is contained in cabinet, with identification, instructions for use, and battery backup power supply.

C. Door Reopening Devices
   1. Photoelectric Device: Provide photoelectric device that projects light beam across car entrance. Interruption of light beam shall cause doors to stop and reopen.

**PART 3 EXECUTION**

**3.1 EXAMINATION**

A. Do not begin installation until preliminary work including hoistway, landings and machine space has been properly prepared.

B. Verify hoistway is constructed in accordance with ASME17.1 /CSA B-44 and all local codes.

C. Verify hoistway and machine room environment is designed to have maintainable temperatures between 50 degrees F (15 degrees C) and 90 degrees F (32 degrees C) and between 5% and 90% non-condensing.
D. Verify machine room if required provided with lighting, light switch and convenience outlet and conforms to CEC and clear space requirements and local codes.
E. Verify hoistway shaft and openings are of correct size and within tolerance.
F. Verify electrical power is available and of correct characteristics.
G. If preliminary work is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION
A. Clean surfaces thoroughly prior to installation.
B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION
A. Install elevator in accordance with applicable regulatory requirements including ASME A17.1 /CSA B-44 and the manufacturer's instructions.
B. Install system components and connect to building utilities.
C. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Reduce clearances to minimum safe workable dimension at each landing.
D. Leveling Tolerance: 1/4 inch, up or down, regardless of load and direction of travel.
E. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, non-metallic grout.
F. Accommodate equipment in space indicated.
G. Startup equipment in accordance with manufacturer's instructions.
H. Adjust for smooth operation.

3.4 FIELD QUALITY CONTROL
A. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed.
B. Perform tests in compliance with ASME A17.1 /CSA B-44 and as required by authorities having jurisdiction.
C. Schedule tests with agencies and Architect, Owner, and Contractor present.
D. Submit test and approval certificates issued by jurisdictional authorities.

3.5 ADJUSTING
A. Adjust for smooth acceleration and deceleration of car so not to cause passenger discomfort.
B. Adjust automatic floor leveling feature at each floor to provide stopping zone of 1/4 inch (6 mm).

3.6 CLEANING
A. Remove protective coverings from finished surfaces.
B. Clean surfaces and components ready for inspection.

3.7 PROTECTION
A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products before Substantial Completion.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to operate, adjust, and maintain elevator. Refer to Division 01 Section "Demonstration and Training."

B. Check operation of elevator with Owner’s personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.

C. Check operation of elevator with Owner’s personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

3.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 month full maintenance by skilled employees of lift installer.
   1. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper lift operation at rated speed and capacity.
   2. Provide parts and supplies same as those used in manufacture and installation of original equipment.

END OF SECTION
SECTION 144200

WHEELCHAIR LIFTS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Vertical wheelchair lift (LIFT-2).
   2. Motor, controls and wiring.
B. Related Sections:
   1. Section 142100 – Electric Traction Elevators.
   2. Section 142600 - Limited-use/Limited-Application Elevators
   3. Division 26: Electrical service to lift equipment.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components, and finishes for lifts.
   2. Include rated capacities, operating characteristics, electrical characteristics, safety features, controls, finishes, and accessories.
B. Shop Drawings: For each lift.
   1. Include plans, elevations, sections, details, attachments to other work, and required clearances.
   2. Indicate dimensions, weights, loads, and points of load to building structure.
   3. Include details of equipment assemblies, method of field assembly, components, and location and size of each field connection.
   4. Include diagrams for power, signal, and control wiring.
C. Samples: Submit samples of side panels for color and appearance acceptance.

1.3 INFORMATIONAL SUBMITTALS
A. Qualification Data: For manufacturer, vendor and Installer.
B. Product Certificates: For each type of lift. Include statement that runway, ramp or pit, dimensions as shown on Drawings, and electrical service as shown and specified are adequate for lift being provided.

1.4 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For each type of lift.
B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted use of lifts.
C. Continuing Maintenance Proposal Submittal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard five year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.5 PROJECT CONDITIONS
A. Examine supporting structure and conditions under which lift is to be installed, and notify Contractor in writing of conditions detrimental to proper and timely completion of work.
B. Coordinate work directly with other subcontractors as necessary to insure proper fitting, joining to or clearance of their work. Furnish or exchange shop drawings and resolve required dimensions and details.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.7 WARRANTY
A. Warranty: Provide a two year limited warranty for wheelchair lift materials and workmanship.
B. Extended Warranty: Provide an extended manufacturer's warranty covering the wheelchair lift materials and workmanship for the following additional extended period beyond the initial two year warranty. Preventive Maintenance Agreement required
   1. Five Years (7 years total)

1.8 MAINTENANCE SERVICE
A. Initial Maintenance Service: Beginning at Substantial Completion, provide one year's full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
   1. Perform maintenance, including emergency callback service, during normal working hours.
   2. Include 24-hour-per-day, 7-day-per-week emergency callback service.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS
A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

2.2 MANUFACTURERS
A. Manufacturers: Subject to compliance with specified requirements, provide Basis of Design or equivalent product by one of the following Manufacturers, and as approved by Architect:
   1. Garaventa Lift (Basis of Design)
   2. Bruno Independent Living Aids, Inc.
   3. Apex Wheelchair Lifts
   4. Symmetry Elevating Solutions
   5. Substitutions: Allowed in accordance with the requirements of Division 1

2.3 PERFORMANCE VERTICAL LIFT
A. (LIFT-2) Vertical Platform Lift:
   1. Basis of Design: Model GVL-EN-168 by Garaventa Lift
   2. Capacity: Capacity: 750 lbs (340 kg) rated capacity
   3. Lifting Height: 156 inches (4343 mm), using hydraulic drive.
   4. Number of Stops: Two.
   5. Nominal Clear Platform Dimensions:
      a. Standard: 37-1/4 inches (947 mm) by 54 inches (1370 mm)
   6. Platform Configuration:
      a. Straight Through Entry/Exit: Front and rear openings
   7. Landing Openings:
a. Lower Landing: Door
b. Upper Landing: Door

8. Doors and Gates: Doors and gates shall be self closing type.
   a. Door Height: Flush mount, 80 inches (2032 mm).
   b. Door Construction: Aluminum frame with:
      1) Panels of 1/4 inch (6 mm) laminated safety glass with 16 gauge (1.5 mm) galvanized steel kick plate.
      2) D-Handle Pull: 12 inch (305 mm) offset D-Handle.

9. Lift Components:
   c. Platform Side Wall Panels: 42-1/8 (1070 mm) inches high. 16 gauge (1.5 mm) galvanized steel sheet. Custom aluminum extrusion tubing frame.
   d. Enclosure Panels:
      1) 16 gauge (1.5 mm) painted galvanized steel sheet.

10. Infill Panel Kit: Provide 16 gauge (1.5 mm) galvanized panels and mounting hardware to cover void between side of enclosure, drive mast and adjacent wall at the following locations:
    a. Lower landing.
    b. Upper landing.

11. Base Mounting and Access to Lift at Lower Landing:
    a. Floor Mount: Base of lift shall be mounted on the floor surface of the lower landing. For access onto the platform provide a ramp of 16 gauge (1.5 mm) galvanized steel sheet with a slip resistant surface.

12. Hydraulic Drive:
    a. Drive Type: Chain hydraulic.
    b. Emergency Operation: Manual device to lower platform and use auxiliary battery power to raise or lower platform.
    c. Safety Devices:
       1) Slack chain safety device.
       2) Shoring device.
    d. Travel Speed: 17 fpm (5.2 m/minute).
    e. Motor: 3.0 hp (2.2 kW); 24 volts DC.
    f. Power Supply:
       1) 120 VAC single phase; 60 Hz on a dedicated 15 amp circuit.
       2) Powered by building continuous mains converted to 24 VDC and equipped with auxiliary battery backup power system capable of running lift up and down for a minimum of 5 trips with rated load. Required for high use lifts and lifts equipped with a fan and ventilation system.

13. Platform Controls: 24 VDC control circuit with the following features.
    a. Direction Control: Illuminated tactile and constant pressure push buttons with dual platform courtesy lights and safety light.
    b. Keyless operation.

14. Call Station Controls: 24 VDC control circuit with the following features.
    a. Direction Control: Illuminated tactile and constant pressure push buttons with illuminated "In Use" indicator.
    b. Keyless operation.
    c. Call Station Mounting:
       1) Lower: Wall mounted recessed.
       2) Upper: Wall mounted recessed.

15. Safety Devices and Features:
    a. Grounded electrical system with upper, lower, and final limit switches.
    b. Tamper resistant interlock to electrically monitor that the door is in the closed position and the lock is engaged before lift can move from landing.
    c. Emergency Operation: Connect to existing emergency power

16. Finishes
    a. Ferrous Components: Electrostatically applied baked powder finish, fine textured.
1) Color: Satin Grey, RAL 7030.
   b. Lift Finish: Baked powder coat finish, color as selected by the Architect from manufacturers
      optional RAL color chart.

2.4 FABRICATION
A. Fabrication, General: Construct lift of steel or aluminum structural frame with welded or bolted
   connections.
B. Verify dimensions on site prior to shop fabrication.
C. Fit and shop assemble in largest practical sections for delivery to site and installation.
D. Supply components required for proper anchorage of lift.
E. All welded parts by a certified welder in accord with AWS/D1.1

PART 3 EXECUTION

3.1 EXAMINATION
A. Do not begin installation until substrates have been properly prepared.
B. Verify shaft and machine space are of correct size and within tolerances.
C. Verify required landings and openings are of correct size and within tolerances.
D. Verify electrical rough-in is at correct location.
E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory
   preparation before proceeding.

3.2 PREPARATION
A. Clean surfaces thoroughly prior to installation.
B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best
   result for the substrate under the project conditions.

3.3 INSTALLATION
A. Install lifts in accordance with applicable regulatory requirements including ASME A 17.1, ASME A
   18.1 and the manufacturer's instructions.
B. Install system components and connect to building utilities.
C. Accommodate equipment in space indicated.
D. Startup equipment in accordance with manufacturer's instructions.
E. Adjust for smooth operation.

3.4 PROTECTION
A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products before Substantial Completion.

3.5 FIELD QUALITY CONTROL
A. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are
   to be performed on lifts.
B. Acceptance Testing: On completion of lift installation and before permitting use of lifts, perform
   acceptance tests as required and recommended by ASME A18.1 and authorities having
   jurisdiction.
C. Operating Test: In addition to acceptance testing, load lifts to rated capacity and operate continuously for 30 minutes between lowest and highest landings served. Readjust stops, signal equipment, and other devices for accurate stopping and operation of system.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lifts. Include a review of emergency systems and emergency procedures to be followed at time of operational failure and other building emergencies.

B. Check operation of lifts with Owner's personnel present and before date of Substantial Completion. Determine that operating systems and devices are functioning properly.

C. Check operation of lifts with Owner's personnel present not more than one month before end of warranty period. Determine that operating systems and devices are functioning properly.

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 month full maintenance by skilled employees of lift Installer.

1. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper lift operation at rated speed and capacity.

2. Provide parts and supplies same as those used in manufacture and installation of original equipment.

END OF SECTION
Project Manual for
Wayne State University
Gateway Theater Complex
Vol. 2
Detroit, Michigan
WSU Proj. No. 189-178578
HAA Proj. No. 2016034.00

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Theatrical / Lighting
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Issued for PERMIT SET
29 JUNE 2020
1.1 DESIGN PROFESSIONALS OF RECORD

ARCHITECT Hamilton Anderson

PLUMBING/HVAC ENGINEER HGA

ELECTRICAL ENGINEER HGA
STRUCTURAL ENGINEER: Desai Nasr

CIVIL ENGINEER: Spalding DeDecker

Thomas Sovel

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END OF SECTION
SECTION 210500
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Design Development
   1. Documents: Design development specifications may include plumbing and HVAC equipment not required for this project. Equipment and capacities are identified on the drawings. Refer to the specifications for equipment characteristics, components, accessories, and installation requirements. These documents are not for construction.

B. GMP pricing documents: This is a preliminary copy of the contract documents. The documents (drawings and project manual) are incomplete and issued to present the design intent. Equipment, material, and labor required to provide complete operating systems shall be included in the GMP.

C. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Grout.
   3. Fire-suppression equipment and piping demolition.
   4. Equipment installation requirements common to equipment sections.
   5. Painting and finishing.
   6. Concrete bases.
   7. Supports and anchorages.

1.3 DEFINITIONS

A. GMP: Guaranteed Maximum Price

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, and spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.

C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

E. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

F. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.
1.4 BASIS-OF-DESIGN
A. Equipment manufacturers listed on the equipment schedules are the basis-of-design. Manufactures listed in the specification other than the basis-of design manufacture are acceptable substitutions. Equipment schedules are on the drawings. Refer to specifications for unscheduled equipment.

1.5 INFORMATIONAL SUBMITTALS
A. Equipment startup reports.
   1. Reports will indicate equipment was started and tested according to the manufactures recommendations and is operating as specified. Included test data.

B. Coordination Drawings: Submit one copy for the engineers use. Division 21 coordination drawings will not be returned.
   1. Detail major elements, components, and systems of fire protection equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
      a. Planned piping layout, including valve and specialty locations and valve-stem movement.
      b. Planned piping hanger layout including building attachments and building structural coordination.
      c. Clearances for installing and maintaining insulation.
      d. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
      e. Equipment and accessory service connections and support details
      f. Exterior wall and foundation penetrations.
      g. Fire- and smoke-rated wall and floor penetration.
      h. Sizes and locations of required concrete equipment curbs and bases.
      i. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
      j. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
      k. Access door and panel locations.
      l. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

1.6 QUALITY ASSURANCE
A. Comply with ASHRAE Guideline 4 – 2008 Preparation of operating and maintenance documentation for building systems.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. All grooved couplings, and fittings, valves and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
   1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.
E. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

F. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

G. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.

1.7 GUIDELINES, CODES AND STANDARDS

A. Refer to the most recently published edition for references to guidelines, and standards unless a specific edition is listed.

B. Installation and materials shall comply with applicable national, state, and local codes and ordinances.

C. In addition to other applicable codes, comply with the Michigan Fire Prevention Code, Act 207; the Michigan State Construction Code, Act 230 as well as all fire safety rules adopted by the State of Michigan Fire Safety Board.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store any plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.


1. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with NFPA-13. Couplings shall be fully installed at visual pad-to-pad offset contact. Couplings that require exact gapping of bolt pads at specific torque ratings are not permitted. Installation-ready, for direct stab installation without field disassembly.
2. Flexible Type: Use in locations where vibration attenuation and stress relief are required.

2.3 JOINING MATERIALS
A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Grooved Joint Lubricants: Lubricate gaskets in accordance with the manufacturer’s published installation instructions, using lubricant compatible with the gasket elastomer and fluid media.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 CONCRETE BASES
A. Refer to Division 03 Section "Cast-in-Place Concrete" or Miscellaneous Cast-in-Place Concrete."

2.5 GROUT
A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
2. Design Mix: 5000-psi, 28-day compressive strength.
PART 3 EXECUTION

3.1 PREPARATION
A. Obtain current fire-hydrant flow test results from the local authority having jurisdiction. Use results for system design calculations required in “Quality Assurance” Article.

3.2 FIRE-SUPPRESSION DEMOLITION
A. Refer to other sections and drawings for general demolition requirements and procedures.
B. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.3 SERVICE-ENTRANCE PIPING
A. Connect fire sprinkler and standpipe piping to water-service piping for service entrance to building. Comply with requirements for exterior piping.
B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS
A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping to permit valve servicing.
G. Install piping at indicated slopes.
H. Install piping free of sags and bends.
I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Verify final equipment locations for roughing-in.
M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.5 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
F. Grooved Joints: Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks. Gaskets shall be molded and produced by the coupling manufacturer, and shall be verified as suitable for the intended service. A factory-trained field representative (direct employee) of the mechanical joint manufacture shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. The factory-trained representative shall periodically review the product installation and ensure best practices are being followed. Contractor shall remove and replace any improperly installed products. A distributor's representative is not considered qualified to conduct the training.
G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

H. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 PAINTING

A. Painting of fire-suppression systems, equipment, and components as specified in other sections.
B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
3.7 CONCRETE BASES

A. Concrete Bases and Curbs:
   1. Provide scaled layouts of bases and curbs with sizes and locations dimensioned to concrete walls and columns.
   2. Determine base and curb sizes and locations based on “Accepted” equipment shop drawings. Base and curb sizes shall not be scaled from the Drawings.
   3. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to vibration requirements at Project.

B. Construction Details: Refer to Architectural Details for base and curb construction types. If not indicated, construct as follows:
   1. Provide concrete bases sized 4 inches larger in both directions than the supported equipment.
   2. Provide 4-inch high curbs and bases with finished edges, unless otherwise indicated.
   3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   6. Install anchor bolts to elevations required for proper attachment to supported equipment.
   7. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   8. Use 3000-psi, 28-day compressive-strength concrete and reinforcement.
   9. Chamfer all outside corners of concrete bases and curbs.

C. Concrete Base Painting: Provide 3” wide safety stripe at outside edge of all concrete bases and curbs. Start paint at bottom edge of chamfer. Color shall be selected by architect.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

B. Field Welding: Comply with AWS D1.1.

3.9 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.
H. Cure placed grout.

3.10 SEALANTS

A. Comply with appropriate joint-sealant materials and applications specified in other sections.

3.11 CYBERSECURITY RISK MITIGATION STRATEGY

A. Coordinate with Owner’s IT Department to restrict external network access to Internet connected system through virtual private network (VPN) connections only.

B. Security Event Log: Coordinate with the Owner to configure security event logging. Access to security logs shall be limited to users with proper authentication. Security logs shall be time stamped with Time and Date metadata for auditing and back-up.

C. Disable any protocols for remote connectivity, unless constantly required for day-to-day operations.

D. All external transport data shall be routed through encrypted channels with 2048-bit secure sockets layer (SSL).

E. Coordinate with Owner’s IT Department to implement a Web server-based human machine interface (HMI) that relies on IT technologies to secure access and restrict ports that can be opened on the firewall. Coordinate with Owner’s IT Department to restrict access to known IP addresses only.

F. Where building system networks are not physically separate from IT business networks, coordinate with Owner’s IT Department to segregate networked and Internet connected systems from the IT business network using virtual local area network (VLAN) IT technologies to restrict internal attacks/breakdowns.

G. Set unique, cryptographically strong passwords for administrator and user accounts. Default passwords must be changed before systems are connected to the Owner’s network.

H. Collect only the data that is necessary for analytics and optimization.

I. References:

4. IEC 62443: Industrial Network and System Security

END OF SECTION
SECTION 210502 - BASIC FIRE PROTECTION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Where contradictions occur between this Section and Division 01, the most stringent of the two shall apply. Architect shall decide which is most stringent.

B. These Basic Requirements apply to the entire Division 21 work.

C. All referenced and related provisions of Divisions 22, 23, 26, 27 and 28 shall also apply to the work of this section as if fully repeated herein.

1.2 SUMMARY

A. The definitions of Division 01 and the General Conditions of the Specification also apply to the Division 21 contract.

B. “Contract Documents” constitute the drawings, specifications, general conditions, project manuals, etc., prepared by engineer (or other design professional in association with Engineer) for contractor's bid or contractor's negotiations with the Owner. The Division 21 drawings and specifications prepared by the Engineer are not Construction Documents.

C. “Construction Documents”, “construction drawings”, and similar terms for Division 21 work refer to installation diagrams, shop drawings and coordination drawings prepared by the contractor using the design intent indicated on the Engineer’s contract documents. These specifications detail the contractor’s responsibility for “Engineering by Contractor” and for preparation of construction documents.

D. “Install” means to "set in place, connect and place in full operational order".
   1. “Provide” means to "furnish and install".

E. “Equal” or “Equivalent” means “meets the specifications of the referenced product or item in all significant aspects”. Significant aspects shall be as determined by the Owner's Representative.

F. “Work by other(s) divisions”, “re:Division”, and similar expressions means work to be performed under the contract documents, but not necessarily under the division or section of the work on which the note appears. It is the contractors’ sole responsibility to coordinate the work of the contract between his/her suppliers, subcontractors and employees. If clarification is required, consult Owner’s Representative before submitting bid.

G. By inference, any reference to a "contractor" or “sub-contractor” means the entity, which has contracted with the Owner for the work of the Contract Documents.

H. “Engineer” means the design professional firm, which has preferred these contract documents. All questions, submittals, etc. of this division shall be routed to the Engineer (through proper contractual channels).

1.3 COORDINATION WITHIN DIVISION 21

A. Contract Documents:
   1. General: The Contract Documents are diagrammatic showing certain physical relationships, which must be established within Division 21 work and its interface with other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing dimensions, clearances or material quantities.
2. Supplemental Instructions: The exact location for some items in this Specification may not be shown on the Drawings. The location of such items may be established by the Owner’s Representative during the progress of the work.

3. Discrepancies:
   a. Examine Drawings and Specifications of all Divisions of the work.
   b. Report any discrepancies to the Owner’s Representative and obtain written instructions before proceeding.
   c. Should there be a conflict within or between the Specifications or Drawings, the most stringent or higher quality requirements shall apply.
   d. Items called for either in the Specifications or on the Drawings shall be required as if called for in both.

4. Constructability:
   a. Examine Drawings and Specifications of all Divisions of the work.
   b. Report any issues to the Owner’s Representative which may prevent installation of Division 21 work in accordance with the Contract Documents and the original construction contract.

B. Contractor shall be responsible for providing proper documentation of equipment product data and shop drawings to all entities providing service.

C. Coordination Drawings: Prepare coordination drawings in accordance with Division 01, Section “Submittals” to scale of 1/4” = 1’-0” or larger, detailing major elements, components, and systems of mechanical equipment (i.e. equipment rooms, and exterior equipment areas) and materials in relationship with other system, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important to the efficient flow of the work, including (but not necessarily limited to) the following:
   1. Indicate all major piping (HVAC, Plumbing and Fire Suppression), electrical equipment and conduits, structural, and architectural elements in these areas as well.
   2. Sizes and locations of required concrete pads, piers, curbs, and bases.
   3. Provide all necessary sections and elements for clarification.
   4. Indicate all seismic restraint and support systems to be used for all mechanical equipment throughout the project.
   5. Ductwork and piping transitions from rooftop units to shafts or horizontal ducts.
   6. Failure to produce or submit coordination drawings does not dismiss the Contractor’s responsibility for translating the design intent of the Contract Documents into Construction Drawings.

D. Deferred Approval Items: Division 01.

E. Utility Connections:
   1. Coordinate the connection of fire protection system with utilities and services.
   2. Comply with regulations of utility suppliers.
   3. The contract documents indicate the available information on existing utilities and services, and on new services (if any) to be provided to the project by utility companies and agencies.
      a. Notify the Owner’s Representative immediately if discrepancies are found.
   4. Coordinate mechanical utility interruptions one week in advance in writing with the Owner’s Representative and the Utility Company.
      a. Plan work so that duration of the interruption is kept to a minimum.

1.4 COORDINATION WITH OTHER DIVISIONS

A. General:
   1. Coordinate the Division 21 work with the progress of the work of the other trades.
   2. Complete the entire installation as soon as the condition of the building will permit.
   3. Contractor is responsible for coordination of his/her work with Owner’s facility staff engaged in building automation, commissioning of systems, fire alarm system, etc.
B. Chases, Inserts and Openings:
1. Provide measurements, drawings, and layouts so that opening, inserts and chases in new construction can be built and coordinated as construction progresses.
2. Check sizes and locations of openings provided.
3. Any cutting and patching made necessary by failure to provide measurements, drawings, and layouts at the proper time shall be done at no additional cost to the Owner.

C. Support Dimensions: Provide dimensions and drawings so that concrete bases and other equipment supports to be provided under other Sections of the Specifications can be built at the proper time.

D. Deferred Approved Items: Division 01.

1.5 ENGINEERING BY CONTRACTOR
A. The construction of this building requires the Contractor to design several systems or subsystems. All such designs shall be the complete responsibility of the Contractor.

B. Systems or subsystems which require responsibility by the Contractor and submitted to the Engineer for review include, but are not limited to:
1. Equipment and piping supports, not detailed in the drawings.
2. Pipe hangers and anchors not specified in these documents, or catalogued by the manufacturer.
4. Thermal pipe stress analysis.

1.6 REGULATORY REQUIREMENTS
A. General:
1. Regulatory Compliance: Work performed under this Division shall comply with the latest currently adopted editions of Codes and Regulations including, but not limited to those listed below.
2. Minimum Requirements: The requirements of the Drawings and Specifications are the minimum that will be allowed, unless such requirements are exceeded by applicable codes or Regulations, in which case the Code or Regulation requirement shall govern.
3. Code Changes: Should a code change occur between time of proposal and date of permit issue, and the Contractor has unnecessarily delayed the acquisition of permits, the contractor shall hold the Owner free from additional expense resulting from such Code change.

B. Codes: Comply With the Currently Adopted (At Time of Contract Award) Codes

C. Comply With the Latest Editions of Applicable Regulations and Standards, Including:
1. Uniform Plumbing Code
3. Underwriter’s Laboratories, Inc. (UL).
6. American Society of Mechanical Engineers (ASME).
9. Compressed Gas Association (CGA).
13. Plumbing and Drainage Institute (PDI).
15. Factory Mutual Standards

D. Requirements of Local Utility Companies: Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment, which will be required for the project.

E. Additional Regulations: Follow additional regulations which appear in individual Sections of these Specifications.

F. Contradictions: Where codes are contradictory, follow the most stringent, unless otherwise indicated in Plans or Specifications. The Owner’s Representative shall determine which is most stringent.

G. Contract Documents Not in Compliance:
   1. Where it is not noted that the Drawings and Specifications do not comply with the minimum requirements of the codes, either notify the Owner’s Representative in writing during the Bidding Period of the revisions required to meet Code Requirements. After entering into contract, Contractor will be held to complete all work necessary to meet Code Requirements without additional expense to the Owner.
   2. Follow Drawings and Specifications where they are superior to Code Requirements.

H. Permits:
   1. Contractor shall pay for and obtain all permits required by authorities and agencies having jurisdiction for the work in this Division.
   2. Post permits as required.

I. Inspections and Tests:
   1. Arrange for all required inspections and tests.
   2. Pay all charges.
   3. Notify the Owner’s Representative in writing 72 hours before tests.
   4. Submit one copy for Owners record of permits. Licenses, inspection reports and test reports.

1.7 EQUIVALENTS AND SUBSTITUTIONS

A. The applicable paragraphs for General Requirements, Division 01 apply herein.

B. Basis for Design: The manufacturer’s name and product listed on the drawings, or listed first of several names in these Specifications, is used as a basis for design to establish space requirements, a standard of quality and performance.

C. Equivalents: Products of one or more other manufacturer’s names listed in these Specifications following the words “or equivalent by” may be selected, subject to paragraph below titled “Contractor’s Responsibility for Equivalent and Substitutions.”

D. Other Options:
   1. For products specified by naming only one manufacturer, refer to paragraph below under “Substitutions”.
   2. For products specified only by performance characteristics or reference standards, select any manufacturer meeting the requirements.

E. Substitutions: Requests for acceptance of a product of manufacturer’s name not listed in these specifications will be considered if any one of the following conditions is met:
   1. The named product is not available because of strikes or discontinuance of manufacture, and the proposed product is equivalent to the named product.
   2. The proposed product is superior to the named product, in the opinion of the Owner’s representative.
3. The proposed product is equivalent to the named product and its use will be to the advantage of the Owner, by the Owner receiving an equitable credit or cost savings. The Owner’s Representative reserves the right to reject any substitution.

4. Submit proposed substitutions with bid along with alternate price, complete descriptive data and a comparison of the substitute manufacturer’s product with specified product. Request for acceptance of a product of manufacturer’s name not listed in these specifications, is subject to the paragraph titled “Contractor’s Responsibility Equivalents and Substitutions”.

F. Contractor’s Responsibility for Equivalents and Substitutions:

1. Items submitted as a substitution to the basis of design or listed general equivalents shall be identified as such and shall include a written request for substitution indicating the following:
   b. Contract time adjustment.
   c. Item by item breakdown of differences between basis of design and substituted item.
   d. Operation, maintenance and energy cost difference.

2. Products of manufacturer must match the features, construction, performance and size of those selected for design. Standard catalogued may require certain modifications to meet specified requirements.

3. The responsibility for providing that specified requirements have been met remains with the manufacturer and contractor. Should the substituted item fail to perform in accordance with the Specifications, replace same with the originally specified item without extra cost to the contract.

4. When requesting review of an equivalent or substituted product, submit a comparison chart listing features, construction, performance and sizes of named product versus equivalent or substituted product.

5. Submittals for review of an equivalent or substituted product will be reviewed for acceptability when all the above requirements have been met. Contractor shall be responsible for all costs incurred by the Architect and Engineer for review of equivalency beyond initial review.

6. Coordinate the installation of the product with all trades.

7. Contractor shall be responsible for changes in electric wiring, materials and for all other additional costs of construction by all trades involved to accommodate the product to perform same as product used on the “Basis of Design”.

8. Coordination of General Equivalents and Substitutions: Where Contract Documents permit selection from general equivalents, or where substitutions are authorized, coordinate clearance and other interface requirements with mechanical and other work.

9. Provide necessary additional items so that selected or substituted item operates equivalent to the Basis of Design and properly fits in the available space allocated for the Basis of Design.

10. Contractor is responsible for assuring that piping, conduit, duct, flue and other service locations for general equivalents or substitutions do not cause access, service or operational difficulties any greater than would be encountered with the Basis of Design.

11. Failure to comply with these requirements will result in immediate rejection of the request for substitution.

1.8 GENERAL SUBMITTAL REQUIREMENTS

A. Refer to Division 01.

B. Coordination and Sequencing:

1. Coordinate submittals 3 weeks (minimum) prior to expected order date so that work will not be delayed by submittals.

2. Do not submit product data, or allow its use on the project until compliance, with requirement of Contract Documents has been confirmed by Contractor.

3. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
4. Submitting contractor is responsible for routing reviewed submittals to all parties affected including but not limited to electrical, building automation and temperature control, and test and balance subcontractors.
5. Make submittals for group of similar products or materials such as valves, fixtures, pumps, insulation, etc., or area of work complete and at one time, not in piecemeal fashion.
6. Identify submittals with Architect’s project name and number, with item designation as indicated on drawings, and referenced to applicable paragraphs of the specifications. Submit in brochure form.
7. Submittals of products needed at start of Project for its installation, or those requiring a long lead time for assembly or manufacturing, should be submitted before the others.

C. Preparations of Submittals:
   1. Refer to Division 01 requirements.
   2. Provide permanent marking on each submittal to identify project, date, Contractor, Subcontractor, Supplier, submittal name and similar information to distinguish it from other submittals.
   3. Indicate any portions of work, which deviate from the Contract Documents.
      a. Explain the reasons for the deviations.
      b. Show how such deviations coordinate with interfacing portions of other work.
   4. Show Contractor’s executed review and approval marking.
   5. Provide space for the Owner’s Representative “Action” marking.
   6. Submittals, which are received from sources other than through Contractor’s office, will be returned “Without Action”.
   7. Submittals shall be presented in a neat and legible fashion and shall be returned “Without Action” if presented in any other fashion.

D. Response to Submittals: Where standard product data has been submitted, it is recognized:
   1. That the Submitter has determined that the products fulfill the specified requirements.
   2. That the submittal is for the Owner’s Representative information only, but will be returned with appropriate action where observed to be not in compliance with the requirements.

E. If more than two submittals (either for shop drawings, as-buils drawings, or test and balance reports) are made by the contractor due to the incompletion, non-compliance, errors, omissions, etc. the Owner reserves the right to charge the contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

1.9 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS

A. Manufacturer’s Data:
   1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black ink to indicate which of the variations is to be provided.
   2. Delete or mark-out significant portions of pre-printed data, which are not applicable.
   3. Where operating ranges are shown, mark data to show portion of range required for project application.
   4. For Each Product, Include the Following:
      a. Sizes.
      b. Weights.
      c. Speeds.
      d. Capacities.
      e. Piping and electrical connection sizes and locations.
      f. Statements of compliance with the required standards and regulations. g. Performance data.
      g. Manufacturer’s specifications and installation instructions.
B. Shop Drawings:
   1. Prepare fire protection shop drawings, except diagrams, to accurate scale.
      a. Show clearance dimensions at critical locations.
   b. Show dimensions of spaces required for operation and maintenance.
   c. Show interfaces with other, work, including structural support.

C. Test Reports:
   1. Submit test reports, which have been signed and dated by the firm performing the test.
   2. Prepare test reports in the manner specified in the standard or regulation governing the test
      procedure (if any) as indicated.

D. Required Equipment and Shop Drawing Submittals:
   1. Provide a submittal schedule with bid.
   2. Provide equipment submittals for each item of equipment specified or scheduled in the Contract
      Documents.
   3. Submittal schedule shall show each item of equipment, applicable section of the Specifications
      where it is described, applicable drawing number and schedule name where it is scheduled,
      date of Contractor’s proposed submittal to the Owner’s Representative, required date to receive
      submittal from the Owner’s Representative and schedule order date.
   4. Provide a Mechanical Shop Drawing Schedule for submission to the Owner’s Representative
      with the Submittal Schedule.

1.10 COMPATIBILITY

A. General: Provide products, which are compatible with other products of the mechanical work, and
   with other work, requiring interface with the mechanical work.

B. Power Characteristics: Where power characteristics are not stated in Division 21 Sections, refer to
   the Sections of Division 26 and the Electrical Drawings for the power characteristics of each power
   driven item of mechanical equipment. Coordinate available power with Electrical Contractor before
   ordering equipment. Mechanical Contractor shall be responsible for ordering equipment to meet
   the available power characteristics. If there is a conflict between Division 21 documents and
   Division 26 documents, provide a written notification to the Owner’s Representative for direction.
   Do not order equipment prior to determining the proper electrical service. No contract cost
   adjustment will be allowed for equipment ordered in conflict with the available power
   characteristics.

1.11 RECORD DRAWINGS

A. Drawings:
   1. Record of Project Progress: Purchase from the Architect a complete set of reproducible
      contract drawings and maintain drawings available at the job site for inspection. Keep an
      accurate, legible and continuously updated record of installed locations and all project revisions
      other than revised drawings issued by the Architect, including source and date of authorization.
      Utilize only contract drawing symbols for recording the work. Drawing notations to be
      sufficiently clear in the representation of the work, for utilization by a CADD operator (drafts
      person) who is not necessarily familiar with the installed work.
   2. Record of Installation: At the conclusion of the work, deliver one (1) set of blue prints of the
      progress drawings to the Owner’s Representative for review. Following the review, Contractor
      shall have incorporated by a competent CADD operator all of the installed data represented on
      the project progress drawings.
   3. Include in Record Drawings the Following:
a. Revisions, including sketches, bulletins, change orders, written addenda and directives, clarifications and responses generated by requests for information (RFIs), regardless of source of the revision.
b. Location and configuration of equipment with related housekeeping pads.
c. Location of fixtures, drains and appurtenances.
d. Physical routing of piping, underground, exposed, and above ceiling with locations of valves and accessories plainly marked and identified.
e. Location of piping below building and on exterior, valves, manholes, appurtenances and stub outs dimensioned from buildings and permanent structures, both horizontally and vertically.
f. Location of wall and ceiling access panels.

B. Acceptance: As a condition for acceptance of the work, deliver two (2) sets of Auto CAD Latest Version CDs and one set of signed and dated reproducible drawings to the Owner’s Representative and obtain a receipt.

1.12 OPERATING AND MAINTENANCE DATA
A. Refer to Division 01 requirements.
B. Submission:
1. Submit three typed and bound copies of Operating and Maintenance (O&M) Manuals prior to scheduling systems demonstrations for the Owner’s Representative, as specified in Division 01.
2. Bind each Maintenance Manual in one or more vinyl covered, 3-ring binders, with pockets for folded drawings.
   a. Mark the spine of each binder with system identification and volume number.
C. Required Contents:
1. Manuals shall have index with tab dividers for each major equipment section to facilitate locating information on a specific piece of equipment.
2. Identify data within each section with drawing code numbers as they appear on Drawings and Specifications. Include as a minimum the following data:
   a. Alphabetical list of system components, with the name, address and 24 hour telephone number of the company responsible for servicing each item during the first year of operation. Include point of contact for company.
   b. Operating instructions for complete system including:
      1) Emergency procedures for fire and failure of major equipment.
      2) Major start, operation and shut down procedures.
   c. Maintenance Instructions for Each Piece of Equipment Including:
      1) Equipment lists.
      2) Proper lubricants and lubricating instructions for each piece of equipment.
      3) Necessary cleaning, replacement and/or adjustment schedule.
      4) Product data.
      5) Installation instructions.
      6) Parts list.
   d. Marked or changed prints locating concealed parts and variations from the original system design (as-built drawings).
   e. Valve schedule and associated piping schematics. See Section 220553, IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT.
   f. Copies of any extended equipment warranties which are greater than one year.

1.13 WARRANTIES
A. The warranty period is two years after Date of Acceptance:
1. During this period, provide labor and materials as required to repair or replace defects in the mechanical system at no additional cost to the Owner. Provide certificate with O&M Manual submittal, which guarantees same-day service response to Owners call for all such warranty service.
2. Provide certificate for such items of equipment, which have warranties in excess of one year. Insert copies in O&M Manuals.
3. Provide extended manufacturers warranties to cover two years from date of acceptance if standard warranty starts any time prior to that date.
4. At time of bid, submit additional costs or extended warranties for principal equipment (e.g. point of use water heaters, pumps, air compressor, etc.).

B. Provide longer warranties where specified in individual specification sections.
C. Refer to Division 01 for additional requirements.

1.14 SPARE PARTS, SPECIAL TOOLS
A. Deliver spare parts to the Owner’s Representative and obtain receipts at the time operating instructions are given to the Owner’s personnel.

B. Include the Following:
1. V-Belts: One complete set of each size.
2. Fuses: each type used for all equipment utilizing fuses. Quantity 10%, but not less than two.
3. Pilot Light Lamps: Each type used on the project. Quantity of 10%, but not less than two.
4. Special Tools: Furnish special tools required for assembly, adjustment, setting or maintenance of equipment if such tool is not readily available on the commercial tool market.
5. Maintenance Paint: Furnish one can of touch-up paint for each different factory finish, which is to be the final finished surface of the product.
6. Alternate Parts: Under the individual mechanical sections, there are listed spare parts to be furnished under a bid alternate. Should the alternate be accepted, such spare parts shall be similarly delivered to the Owner.

1.15 SYSTEM ACCEPTANCE
A. Acceptance shall be contingent upon completion of final review and correction of all deficiencies. Satisfactory completion of the operational tests, which shall demonstrate compliance with all performance criteria, and the requirements of the Contract Documents.

B. Request a Final Review Prior to System Acceptance After Completion of the Following:
1. Installation of all systems required by Contract Documents.
2. Submission and acceptance of service manuals.
3. Identification.
4. Cleaning.
5. Satisfactory operation of all systems for a period of one week.

1.16 MANDATORY GOVERNING PROVISION
A. Omissions of words or phrases, such as “the Contractor shall”, in conformity with”, “shall be”, “as noted on the Drawings”, “according to the Drawings”, “an”, “the”, and “all” are intentional.

B. Omitted words or phrases shall be supplied by inference.

1.17 OWNER FURNISHED EQUIPMENT
A. All equipment called out in the Specifications or shown on the Drawings as “Owner Furnished Equipment” shall be installed and connected under this contract. Provide rough-ins for all future connections indicated, unless otherwise specifically indicated on Drawings.
1.18 TEMPORARY FACILITIES
A. Light, heat, power, etc.
   1. Contractor shall be responsible for providing temporary electricity, heat and other facilities as specified in Division 01.
   2. Contractor shall be responsible for maintaining the equipment in an as-new condition. Equipment will not be turned over to the Owner until it is brought up to as-new condition.

1.19 SAFETY PROVISIONS
A. Equipment Nameplates: provide power-oriented fire protection equipment with a permanent nameplate attached by the manufacturer, indicating:
   1. The manufacturer.
   2. Product name.
   3. Model number.
   4. Serial number.
   5. Speed.
   6. Capacity.
   7. Power characteristics.
   8. Labels of testing, or inspecting agencies.
   9. Other similar data.
B. Where manufacturer affixed nameplate is not available, Contractor shall fabricate and attach nameplate.
C. Guards:
   1. Unless equivalent guards are provided integral with the equipment, enclose each belt drive (including sheaves) on both sides in a galvanized, one inch, mesh screen of No. 18 gauge steel wire or expanded metal, fastened to an approved, structural steel frame, securely fastened to the equipment or floor.
   2. Provide tachometer holes at shaft centers. Unless equivalent guards are provided integral with the equipment, install a solid guard of No. 20 gauge galvanized steel over the coupling of each item of direct-driven equipment.
   3. Sides are not required on these guards except to ensure rigidity.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 INSTALLATION GENERAL REQUIREMENTS
A. Furnish, apply, install, connect, erect, clean, and condition manufactured materials and equipment as recommended in manufacturer’s printed directions (maintained on job site during installation).
B. Provide all attachment devices and materials necessary to secure materials together or to other materials.
C. Make allowance for ample and normal expansion and contraction for all building components and piping systems that are subject to such.
D. Install materials only when conditions of temperature, moisture, humidity and conditions of adjacent building components are conducive to achieving the best installation results.
E. Erect, install and secure components in a structurally sound and appropriate manner.
F. Where necessary, temporarily brace, shore, or otherwise support members until final connections are installed.

G. Leave all temporary bracing, shoring, or other structural supports in place as long as practical for safety and to maintain proper alignment.

H. Handle materials in a manner to prevent scratching, abrading, distortion, chipping, breaking, or other disfigurement.

I. Conduct work in a manner to avoid injury or damage to previously placed work.

J. Any work so impaired or damaged shall be replaced at no expense to Owner.

K. Fabricate and install materials true to line, plumb and level.

L. Leave finished surfaces smooth and flat, free from wrinkles, wraps, scratches, dents and other imperfections.

M. Furnish materials in longest practical lengths and largest practical sizes to avoid all unnecessary jointing.

N. Make all joints secure, tightly fitted, and as inconspicuous as possible by the best, accepted practice in joinery and fabrication.

O. Consult the Owner’s Representative for mounting height or position of any unit not specifically indicated or located on Drawings or specified in Specifications.

P. Job mixed multi-component materials used in the work shall be mixed in such regulated and properly sized batches that material can be used before it begins to “set”.

Q. Mixing of a partially “set” batch with another batch of fresh materials will not be accepted and entire batch shall be discarded and removed from site.

R. Clean all mixing tools and appliances that can be contaminated prior to mixing of fresh materials.

S. In addition to the above, refer to each Section of the Specifications for additional installation requirements for the proper completion of all work.

3.2 COORDINATION OF FIRE PROTECTION INSTALLATION

A. Inspection and Preparation:
   1. Examine the work interfacing with fire protection work, and the conditions under which the work will be preformed, and notify the Owner’s Representative of conditions detrimental to the proper completion of the work at original contract price.
   2. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Layout:
   1. Layout the dire protection work in conformity with the Contract Drawings, Coordination Drawings and other Shop Drawings, product data and similar requirements so that the entire fire protection system will perform as an integrated system, properly interfaced with other work recognizing that portions of the work are shown only in diagrammatic form.
   2. Where coordination requirements conflict with individual system requirements, comply with the Owner’s Representative decision on resolution of the conflict.
   3. Take necessary field measurements to determine space and connection requirements.
   4. Provide sizes and shapes of equipment so the final installation conforms to the intent of the Contract Documents.
   5. Provide necessary fittings to create offsets as required to coordinate with building structure and other trades, even if fittings are not shown on the Contract Drawings.
C. Integrate fire protection work in ceiling spaces with the ceiling suspension system, light fixtures and other work, so that required performance of each will be achieved.

3.3 PRODUCT INSTALLATION

A. Manufacturer's instructions:
   1. Except where more stringent requirements are indicated, comply with the product manufacturer's instructions and recommendations.
   2. Consult with manufacturer's technical representatives, who are recognized as technical experts, for specific instructions on special projects conditions.
   3. If conflict exists, notify the Owner's in writing and obtain his instruction before proceeding with the work in question.

B. Movement of Equipment:
   1. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed.
   2. Otherwise, advise Contractor of opening requirements to be maintained for the subsequent entry of equipment.

C. Heavy Equipment:
   1. Coordinate the movement of heavy items with shoring and bracing so that the building structure will not be overloaded during the movement and installation.
   2. Where fire protection products to be installed on the existing roof are too heavy to be hand-carried, do not transport across the existing roof deck. Position by crane or other device so as to avoid overloading or otherwise damaging the roof deck.

D. Clearances:
   1. Install Piping:
      a. Straight and true.
      b. Aligned with other work.
      c. Close to walls and overhead structure (allowing for insulation).
      d. Concealed, where possible, in occupied spaces.
      e. Out-of-the-way with maximum passageway and headroom remaining in each space.
   2. Do not obstruct windows, doors and other openings.
   3. Coordinate location of piping systems required to slope for drainage (over other service lines and ductwork).

E. Access:
   1. Provide For Removal, Without Damage To Other Parts, Of:
      a. Seals.
      b. Shafts.
      c. Gaskets.
      d. Drives.
      e. Filters.
      f. Strainers.
      g. Bearings.
      h. Control components.
      i. Other parts requiring periodic replacement or maintenance.
   2. Connect equipment for ease of disconnecting with minimum of interference with other work.
   3. Provide unions where required.
   4. Locate operating and control equipment and devices for easy access.
   5. Provide access panels where equipment or devices are concealed by non-accessible finishes and similar work.
6. Ensure grease fittings for equipment are readily visible and accessible. Extend fittings when necessary.

3.4 PROTECTION OF WORK
A. Provide protection against dust migration, rain, wind, storms, frost, or heat, so as to maintain all work, materials, apparatus and fixtures free from injury or damage.
B. At end of each day’s work, cover all new work likely to be damaged.
C. Do not interrupt the integrity of the building security overnight.
D. Refer to Division 01 for additional requirements.
E. All pipe ends, valves and equipment left unconnected shall be capped, plugged or otherwise properly protected to prevent damage and the intrusion of foreign matter.
F. Any equipment or piping systems found to have been damaged or contaminated above “MILL” or “SHOP” conditions shall be replaced or cleaned to the Owner’s Representative satisfaction.
G. Provide initial water seal fill for all waste P-traps or similar traps.

3.5 PROTECTION OF POTABLE WATER SYSTEMS
A. All temporary water connections shall be made with an approved back flow preventer.
B. All hose bibs shall have as a minimum, a vacuum breaker, to prevent back flow.
C. Direct connections to hydronic systems shall only be made through a reduced pressure back flow preventer.

3.6 OBJECTIONABLE NOISE AND VIBRATION
A. Mechanical equipment and piping system shall operate without objectionable noise and vibration, as determined by the judgment of the Owner's Representative.
B. If objectionable noise and vibration should be produced, make necessary changes or additions required to produce satisfactory result without additional cost to the Owner.

3.7 CLOSING-IN OF UN-INSPECTED WORK
A. Do not allow or cause any work to be covered up or enclosed until inspected, tested and approved.
B. Should any work be enclosed or covered up before such inspection and test, Contractor shall, at his/her own expense, uncover work and after it has been inspected, tested and approved, make repairs with such materials as necessary to restore his/her work and that of other Divisions to original and proper condition.

3.8 CLEANING
A. After installation is complete, clean all systems as indicated below.
B. Piping and Equipment To Be Insulated: Clean exterior thoroughly to remove rust, plaster, cement and dirt before insulation is applied.
C. Piping and Equipment Remain Un-insulated: Clean exterior thoroughly to remove rust, plaster, cement, dirt and other foreign substances.
D. Piping and Equipment To Be Painted: Clean exterior to be exposed in completed structure. Remove rust, plaster, cement and dirt by wire brushing. Remove grease, oil and other foreign materials by wiping with clean rags and suitable solvents.
E. During Progress of Work: Carefully clean up the premises and keep all portions of the building free of debris.

F. Chrome Or Nickel Plated Work: Thoroughly polish.

3.9 DAMAGE RESPONSIBILITY
A. Contractor shall be responsible for damage to the grounds, buildings or equipment and the loss of refrigerants, fuels or gases, caused by leaks or breaks in pipes for equipment furnished or installed under this Division.

3.10 PRELIMINARY OPERATION
A. The Owner’s Representative reserves the right to operate portions of the mechanical system on a preliminary basis without voiding the guarantee or relieving the Contractor of his/her responsibilities.

3.11 OPERATIONAL TESTS
A. Before operational tests are performed, demonstrate to the Owner’s Representative that systems and components are complete and fully charged with operating fluid and lubricants. Systems shall be operable and capable of maintaining continuous uninterrupted operation during the operating and demonstration period.

B. After systems have been completely installed, connections made, and tests completed, operate the systems continuously for a period of five working days during the hours of a normal working day.

C. Rotating equipment shall be in dynamic balance and alignment.

D. Tests required in various sections herein shall be completed.

E. Notify the Owner’s Representative, in writing, two weeks in advance of this operational period.

F. This operational test may be concurrent with instruction of the Owner’s operating personnel.

3.12 COMPLIANCE TESTS
A. Conduct tests for individual components, such as chiller, boiler, cooling tower, air handling unit, etc. of all portions of the installation as may be required by the various Sections of this Division to comply with the Contract Documents. Tests shall be made in the presence of the Owner’s Representative. Costs of tests shall be borne by the Contractor. Contractor shall provide all instruments, equipment, labor and materials to complete the tests. These tests may be required at any time between the installation of the work and the end of the warranty period. Should these tests expose any defective materials, poor workmanship or variance with requirements of Contract Documents, Contractor shall make any changes necessary and remedy any defects at no cost to the Owner.

END OF SECTION
SECTION 210517
SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Sleeves.
   2. Sleeve-seal systems.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 SLEEVES
A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.
   3. Metraflex Company (The).
   4. Pipeline Seal and Insulator, Inc.
   5. Proco Products, Inc.
B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Holdrite.
B. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping OD.

2.4 GROUT
B. Characteristics: Non-shrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION
A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes in walls.
C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas, pipe chases, or other wet areas 2 inches above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in "Joint Sealants."
E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements for fire stopping specified in "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION
A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION
A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

END OF SECTION
SECTION 210518
ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 ESCUTCHEONS
A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener
   One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
C. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES
A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 EXECUTION

3.1 INSTALLATION
A. Install escutcheons for exposed piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      c. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
d. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

e. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

2. Escutcheons for Existing Piping in Renovated Areas:
   a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
   b. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.
   2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION
SECTION 210523
GENERAL-DUTY VALVES FOR FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Two-piece ball valves with indicators.
   2. Iron butterfly valves with indicators.
   3. Check valves.
   4. Bronze OS&Y gate valves.
   5. Iron OS&Y gate valves.
   6. NRS gate valves.
   7. Indicator posts.
   8. Trim and drain valves.

1.3 DEFINITIONS
A. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
B. NRS: Nonrising stem.
C. OS&Y: Outside screw and yoke.
D. SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooved ends, and weld ends.
B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.
D. Protect flanges and specialties from moisture and dirt.

General-Duty Valves for Fire-Suppression Piping
PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Main Level: HAMV - Fire Main Equipment.
   a. Level 1: HCBZ - Indicator Posts, Gate Valve.
   b. Level 1: HLOT - Valves.
      1) Level 3: HLUG - Ball Valves, System Control.
      2) Level 3: HLXS - Butterfly Valves.
      3) Level 3: HMER - Check Valves.
      4) Level 3: HMRZ - Gate Valves.

   a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:
   a. Indicator posts.
   b. Valves.
      1) Gate valves.
      2) Check valves.
         (a) Single check valves.
      3) Miscellaneous valves.

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B1.20.1 for threads for threaded-end valves.
3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 24 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

H. Valve Sizes: Same as upstream piping unless otherwise indicated.

I. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 TWO-PIECE BALL VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. NIBCO, Inc. (www.nibco.com)
2. Victaulic Company (www.victaulic.com)

B. Description:

1. UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.
7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Weatherproof actuator housing with worm gear or traveling nut.
10. Supervisory Switch: Internal or external.
11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.

2.3 IRON BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Globe Fire Sprinkler Corporation (www.globesprinkler.com)
2. Kennedy Valve Company; a division of McWane, Inc. (www.kennedyvalve.com)
3. Nibco Inc. (www.nibco.com)
4. Tyco Fire & Building Products (www.tyco-fire.com)
5. Victaulic Company (www.victaulic.com)
6. Zurn Industries, LLC (www.zurn.com)

B. Description:
1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
3. Body Material: Cast or ductile iron.
4. Seat Material: Pressure responsive EPDM.
5. Stem: Stainless steel.
   a. Stem shall be offset from the disc centerline to allow complete 360 degree circumferential seating.
6. Disc: Ductile iron.
7. Actuator: Weatherproof actuator housing with worm gear or traveling nut.
8. Supervisory Switch: Internal or external.

2.4 CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Anvil International (www.anvilintl.com)
2. Fire Protection Products, Inc. (www.fppi.com)
4. Kennedy Valve Company; a division of McWane, Inc. (www.kennedyvalve.com)
5. Matco-Norca (www.matco-norca.com)
7. Reliable Automatic Sprinkler Company (www.reliablesprinkler.com)
8. Shurjoint Piping Products (www.shurjoint.com)
9. Tyco Fire & Building Products (www.tyco-fire.com)
10. United Brass Works, Inc. (www.ubw.com)
12. Victaulic Company (www.victaulic.com)
13. Viking Corporation (www.vikingcorp.com)
14. Watts; a Watts Water Technologies Company (www.wattswater.com)
15. Wilson & Cousins Inc. (www.wilsonandcousins.com)
16. Zurn Industries, LLC (www.zurn.com)
B. Description:
3. Type: Spring assisted single swing check.
4. Suitable for horizontal or vertical installation.
5. Body Material: Cast iron, ductile iron, or bronze.
6. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
7. Clapper Seat: Brass, bronze, or stainless steel.
8. Hinge Shaft: Bronze or stainless steel.
10. End Connections: Flanged, grooved, or threaded.

2.5 BRONZE OS&Y GATE VALVES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Milwaukee Valve Company (www.milwaukeevalve.com)
   2. NIBCO, Inc. (www.nibco.com)
   3. United Brass Works, Inc. (www.ubw.com)
   4. Zurn Industries, LLC (www.zurn.com)
B. Description:
   3. Body and Bonnet Material: Bronze or brass.
   4. Wedge: One-piece bronze or brass.
   5. Wedge Seat: Bronze.
   6. Stem: Bronze or brass.
   7. Packing: Non-asbestos PTFE.
   8. Supervisory Switch: External.

2.6 IRON OS&Y GATE VALVES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. NIBCO, Inc. (www.nibco.com)
   2. Victaulic Company (www.victaulic.com)
   3. Watts; a Watts Water Technologies Company (www.wattswater.com)
   4. Zurn Industries, LLC (www.zurn.com)
B. Description:
   3. Body and Bonnet Material: Cast or ductile iron.
   4. Wedge: Cast or ductile iron, or bronze.
   5. Wedge Seat: Cast or ductile iron, or bronze.
   6. Stem: Brass or bronze.
   7. Packing: Non-asbestos PTFE.
   8. Supervisory Switch: External.

2.7 NRS GATE VALVES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. NIBCO, Inc. (www.nibco.com)
2. Victaulic Company (www.victaulic.com)
3. Zurn Industries, LLC (www.zurn.com)

B. Description:
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron.
5. Wedge Seat: Cast or ductile iron, or bronze.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.

2.8 INDICATOR POSTS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Cast Iron Pipe Company (www.american-usa.com)
2. Clow Valve Company; a subsidiary of McWane, Inc. (www.clowvalve.com)
3. Kennedy Valve Company; a division of McWane, Inc. (www.kennedyvalve.com)
5. NIBCO, Inc. (www.nibco.com)
6. Victaulic Company (www.victaulic.com)

B. Description:
2. Type: Wall.
3. Base Barrel Material: Cast or ductile iron.
4. Cap: Cast or ductile iron.

2.9 TRIM AND DRAIN VALVES
A. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. NIBCO, Inc. (www.nibco.com)
   b. Victaulic Company (www.victaulic.com)
   c. Watts; a Watts Water Technologies Company (www.wattswater.com)
   d. Zurn Industries, LLC (www.zurn.com)
2. Description:
   b. Body Design: Two piece.
   c. Body Material: Forged brass or bronze.
   d. Port size: Full or standard.
   e. Seats: PTFE.
   f. Stem: Bronze or stainless steel.
   g. Ball: Chrome-plated brass.
   h. Actuator: Handlever.
   i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
   j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.
B. Angle Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. NIBCO, Inc. (www.nibco.com)
      c. United Brass Works, Inc. (www.ubw.com)
   2. Description:
      b. Body Material: Brass or bronze.
      c. Ends: Threaded.
      d. Stem: Bronze.
      e. Disc: Bronze.
      f. Packing: Asbestos free.
      g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. NIBCO, Inc. (www.nibco.com)
      b. United Brass Works, Inc. (www.ubw.com)
   2. Description:
      c. Ends: Threaded.
      d. Stem: Bronze.
      e. Disc Holder and Nut: Bronze.
      f. Disc Seat: Nitrile.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine grooved ends for form and cleanliness. Grooved ends shall be clean and free from indentations or projections in the area from valve or fitting end to (and including) the groove.
E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
F. Do not attempt to repair defective valves; replace with new valves.

3.2 GENERAL REQUIREMENTS FOR VALVE INSTALLATION
A. Comply with requirements in the following Sections for specific valve installation requirements and applications:
1. Division 21 "Fire-Suppression Standpipes" for application of valves in fire-suppression stand-pipes.
2. Division 21 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements in Division 21 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.

I. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

END OF SECTION
SECTION 210529
HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following hangers and supports for fire suppression systems piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Fastener systems.
   5. Equipment supports.

1.3 DEFINITIONS
A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Incorporated
B. Terminology: As defined in MSS SP-90, “Guidelines on Terminology for Pipe Hangers and Supports.”

1.4 PERFORMANCE REQUIREMENTS
A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS
A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Powder-actuated fastener systems.
   3. Pipe positioning systems.
B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Pipe stands. Include Product Data for components.
   4. Equipment supports.

1.6 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   4. ASME Boiler and Pressure Vessel Code: Section IX.
PART 2 PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS
A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
B. Manufacturers:
   1. AAA Technology & Specialties Company, Incorporated (www.aaatech.com)
   2. Anvil International (www.anvilintl.com)
   4. B-Line Systems, Incorporated; a division of Cooper Industries (www.cooperindustries.com)
   5. Carpenter & Paterson, Incorporated; a division of Cooper Industries (www.carpenterandpaterson.com)
   6. Empire Industries, Incorporated (www.empireindustries.com)
   7. ERICO/Michigan Hanger Company (www.erico.com)
  10. PHD Manufacturing, Incorporated (www.phd-mfg.com)
  11. PHS Industries, Incorporated
  13. Tolco Incorporated; a division of Cooper Industries (www.cooperindustries.com)
C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.3 TRAPEZE PIPE HANGERS
A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS
A. Description: MFMA-4, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
B. Manufacturers:
   1. B-Line Systems, Incorporated; a division of Cooper Industries (www.cooperindustries.com)
   2. ERICO/Michigan Hanger Company (www.erico.com)
   3. Power-Strut Division; Tyco International, Ltd. (www.powerstrut.com)
   4. Thomas & Betts Corporation (www.tnb.com)
   5. Tolco Incorporated; a division of Cooper Industries (www.cooperindustries.com)
   6. Unistrut Corporation; a part of Atkore International (www.unistrut.us)
C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. Hilti, Incorporated (www.us.hilti.com)
      b. ITW Ramset/Red Head (www.ramset.com)
      c. MKT Fastening, LLC (www.mkffastening.com)
      d. Powers Fasteners (www.powers.com)

B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. B-Line Systems, Incorporated; a division of Cooper Industries (www.cooperindustries.com)
      b. Empire Industries, Incorporated (www.empireindustries.com)
      c. Hilti, Incorporated (www.us.hilti.com)
      d. ITW Ramset/Red Head (www.ramset.com)
      e. MKT Fastening, LLC (www.mkffastening.com)
      f. Powers Fasteners (www.powers.com)

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Shared hangers and supports with other systems that have vibration control devices is prohibited.

B. Attachments to metal roof decks will not be permitted.

C. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

D. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

E. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated; install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
   3. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
   4. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
5. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
   3. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      a. Light (MSS Type 31): 750 lb.
      b. Medium (MSS Type 32): 1500 lb.
      c. Heavy (MSS Type 33): 3000 lb.
   4. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

J. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

K. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

L. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs greater than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer’s operating manual.

2. Install mechanical fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured.

3. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer’s written instructions.

E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.3 EQUIPMENT SUPPORTS
A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS
A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING
A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING
A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7 CLEANING
A. Clean exposed hangers and supports located finished spaces.

END OF SECTION
SECTION 210553
IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Valve tags.
   5. Warning tags.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification material and device.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
D. Valve numbering scheme.
E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS
A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: White
   3. Background Color: Red
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   7. Fasteners: Stainless-steel rivets or self-tapping screws.
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.


C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semi rigid plastic formed to [partially cover] [cover full] circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.
2.5 WARNING TAGS
A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 EXECUTION

3.1 PREPARATION
A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION
A. Install or permanently fasten labels on each major item of fire suppression equipment.
B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION
A. Where piping is exposed to view from public below, locate labels on top of piping just outside of public view.
B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
C. Pipe Label Color Schedule:
   1. Fire Suppression Piping:
      a. Background Color: Red.

3.4 VALVE-TAG INSTALLATION
A. Install tags on valves and control devices in piping systems. List tagged valves in a valve schedule.
B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      b. Compressed Air: 1-1/2 inches round.
   2. Valve-Tag Color: Red

3.5 WARNING-TAG INSTALLATION
   A. Attach warning tags to, equipment and other items where required.

END OF SECTION
SECTION 211119
FIRE-DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Exposed-type fire-department connections.
   2. Flush-type fire-department connections.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

PART 2 PRODUCTS

2.1 EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Fire Hose & Cabinet (www.americanfirehose.com)
   2. Elkhart Brass Mfg. Co., Inc. (www.elkhartbrass.com)
   4. Fire-End & Croker Corporation (www.croker.com)
   5. GMR International Equipment Corporation (www.gmr-fire.com)
   8. Wilson & Cousins Inc. (www.wilsonandcousins.com)
B. Standard: UL 405.
C. Type: Exposed, projecting, for wall mounting.
D. Pressure Rating: 175 psig minimum.
E. Body Material: Corrosion-resistant metal.
F. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
G. Caps: Brass, lugged type, with gasket and chain.
H. Escutcheon Plate: Round, brass, wall type.
I. Outlet: Back, with pipe threads.
J. Number of Inlets: Three.
K. Escutcheon Plate Marking: Similar to “AUTO SPKR & STANDPIPE.”
L. Finish: Rough brass or bronze.
M. Outlet Size: NPS 4.

2.2 FLUSH-TYPE FIRE-DEPARTMENT CONNECTION
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Fire Hose & Cabinet (www.americanfirehose.com)
   2. Elkhart Brass Mfg. Co., Inc. (www.elkhartbrass.com)
   3. GMR International Equipment Corporation (www.gmr-fire.com)
   5. Potter Roemer LLC (www.potterroemer.com)
B. Standard: UL 405.
C. Type: Flush, for wall mounting.
D. Pressure Rating: 175 psig minimum.
E. Body Material: Corrosion-resistant metal.
F. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
G. Caps: Brass, lugged type, with gasket and chain.
H. Escutcheon Plate: Rectangular, brass, wall type.
I. Outlet: With pipe threads.
J. Body Style: Horizontal.
K. Number of Inlets: Three.
L. Outlet Location: Back or Top.
M. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
N. Finish: Rough brass or bronze.
O. Outlet Size: NPS 4.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.
B. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install wall-type fire-department connections.
B. Install two protective pipe bollards on sides of each fire-department connection.
C. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.
SECTION 211200
FIRE-SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Pipes, fittings, and specialties.
   2. Fire-protection specialty valves.
   3. Hose connections.
   6. Control panels.
   7. Pressure gages.
B. Related Sections:
   1. Division 21 Section "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.
   2. Division 21 Section "Electric-Drive, Centrifugal Fire Pumps" for fire pumps, pressure-maintenance pumps, and fire-pump controllers.
   3. Division 28 Section "Digital, Addressable Fire-Alarm System" for alarm devices not specified in this Section.

1.3 DEFINITIONS
A. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure 175 psig maximum.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings: For fire-suppression standpipes.
   1. Include plans, elevations, sections, and attachment details.
   2. Include diagrams for power, signal, and control wiring.
C. Delegated-Design Submittal: For standpipe systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS
A. Approved Standpipe Drawings: Working plans, prepared according to NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
B. Fire-hydrant flow test report.
C. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."

D. Field quality-control reports.

**1.6 CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For fire-suppression standpipes specialties to include in emergency, operation, and maintenance manuals.

**1.7 QUALITY ASSURANCE**

A. Installer Qualifications:
   1. Installer’s responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14, "Installation of Standpipe and Hose Systems."

**1.8 PROJECT CONDITIONS**

A. Interruption of Existing Fire-Suppression Standpipe Service: Do not interrupt fire-suppression standpipe service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire-suppression standpipe service according to requirements indicated:
   1. Notify Architect and Owner no fewer than two days in advance of proposed interruption of fire-suppression standpipe service.
   2. Do not proceed with interruption of fire-suppression standpipe service without Owner’s written permission.

**PART 2 PRODUCTS**

**2.1 SYSTEM DESCRIPTIONS**

A. Automatic Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

B. Automatic Wet-Type, Class II Standpipe System: Includes NPS 1-1/2 hose stations. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

C. Automatic Wet-Type, Class III Standpipe System: Includes NPS 1-1/2 hose stations and NPS 2-1/2 hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.
2.2 PERFORMANCE REQUIREMENTS
A. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig minimum working pressure.
B. Delegated Design: Design fire-suppression standpipes, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
C. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.
   1. Minimum residual pressure at each hose-connection outlet is as follows:
      a. NPS 1-1/2 Hose Connections: 65 psig
      b. NPS 2-1/2 Hose Connections: 100 psig.

2.3 PIPING MATERIALS
A. Comply with requirements in “Piping Schedule” Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.4 BLACK STEEL PIPE AND ASSOCIATED FITTINGS
A. Schedule 40: ASTM A 53/A 53M, Type E, Grade B; with factory- or field-formed ends to accommodate joining method.
B. Schedule 40: ASTM A 135/A 135M, Grade A; with factory- or field-formed ends to accommodate joining method.
C. Schedule 40: ASTM A 795/A 795M, Type E, Grade A; with factory- or field-formed ends to accommodate joining method.
D. Schedule 30: ASTM A 53/A 53M, Type E, Grade B; with factory- or field-formed ends to accommodate joining method.
E. Schedule 30: ASTM A 135/A 135M, Grade A; with factory- or field-formed ends to accommodate joining method.
F. Schedule 30: ASTM A 795/A 795M, Type E, Grade A; with factory- or field-formed ends to accommodate joining method.
G. Thinwall: ASTM A 53/A 53M, Type E; with wall thickness less than Schedule 30 and equal to or greater than Schedule 10; and with factory- or field-formed ends to accommodate joining method.
H. Thinwall: ASTM A 135/A 135M, Grade A; with wall thickness less than Schedule 30 and equal to or greater than Schedule 10; and with factory- or field-formed ends to accommodate joining method.
I. Thinwall: ASTM A 795/A 795M, Type E, Grade A; with wall thickness less than Schedule 30 and equal to or greater than Schedule 10; and with factory- or field-formed ends to accommodate joining method.
J. Schedule 10: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
K. Lightwall: ASTM A 135/A 135M, [Grade A] <Insert grade>; ASTM A 795/A 795M, [Type E] <Insert type>, [Grade A] <Insert grade>, with wall thickness less than Schedule 10 and greater than Schedule 5.
L. Uncoated, Steel Couplings: ASTM A 865/A 865M, threaded.
N. Malleable- or Ductile-Iron Unions: UL 860.

P. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.


R. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International (www.anvilintl.com)
      b. Shurjoint Piping Products (www.shurjoint.com)
      c. Smith-Cooper International (www.smithcooper.com)
      d. Tyco Fire & Building Products LP (tyco-fire.com)
      e. Victaulic Company (www.victaulic.com)
   2. Pressure Rating: [175 psig] [250 psig] [300 psig] minimum.
   3. [Galvanized] [and] [Uncoated], Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
   4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.5 GALVANIZED-STEEL PIPE AND ASSOCIATED FITTINGS

A. Schedule 40: ASTM A 53/A 53M, Type E, Grade B; with factory- or field-formed ends to accommodate joining method.

B. Schedule 40: ASTM A 135/A 135M, Grade A; with factory- or field-formed ends to accommodate joining method.

C. Schedule 40: ASTM A 795/A 795M, Type E, Grade A; with factory- or field-formed ends to accommodate joining method.


E. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable-Iron Unions:
   1. ASME B16.39, Class 150.
   2. Hexagonal-stock body.
   4. Threaded ends.

G. Flanges: ASME B16.1, Class 125, cast iron.

H. Appurtenances for Grooved-End, Galvanized-Steel Pipe:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International (www.anvilintl.com)
      b. Grinnell Mechanical Products (www.grinnell.com)
      c. Shurjoint Piping Products (www.shurjoint.com)
      d. Victaulic Company (www.victaulic.com)
   2. Fittings for Grooved-End, Galvanized-Steel Pipe: Galvanized, ASTM A 47/A 47M, malleable-iron casting; ASTM A 106/A 106M, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
   3. Fittings for Grooved-End, Galvanized-Steel Pipe:
a. AWWA C606 for steel-pipe dimensions.
b. Ferrous housing sections.
c. EPDM-rubber gaskets suitable for hot and cold water.
d. Bolts and nuts.
e. Minimum Pressure Rating:
   1) NPS 8 and Smaller: [600 psig] <Insert value>.
   2) NPS 10 and NPS 12: [400 psig] <Insert value>.
   3) NPS 14 to NPS 24: [250 psig] <Insert value>.

2.6 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: [AWWA C110, rubber, flat face, 1/8 inch thick] [or]
   [ASME B16.21, nonmetallic and asbestos free].
   1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
   2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.7 SPECIALTY VALVES

A. General Requirements:
      FM Global, listing.
   2. Pressure Rating:
      a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
      b. High-Pressure Piping Specialty Valves: [250 psig minimum] [300 psig].
   3. Body Material: Cast or ductile iron.
   4. Size: Same as connected piping.
   5. End Connections: Flanged or grooved.
B. Alarm Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the
      following:
      a. Globe Fire Sprinkler Corporation. (globe-sprinkler.com)
      b. Reliable Automatic Sprinkler Company, Incorporated (www.reliablesprinkler.com)
      c. Tyco Fire & Building Products LP. (tyco-fire.com)
      d. Venus Fire Protection Ltd. (www.venus-fire.com)
      e. Victaulic Company. (www.victaulic.com)
      f. Viking Corporation. (www.vikingcorp.com)
   3. Design: For horizontal or vertical installation.
   4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding
      chamber, and fill-line attachment with strainer.
   5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
   6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
C. Automatic (Ball Drip) Drain Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the
      following:
a. Kidde Fire Fighting; A UTC Business Unit (www.kidde-fire.com)
b. Reliable Automatic Sprinkler Company, Incorporated (www.reliablesprinkler.com)
c. Tyco Fire & Building Products LP. (tyco-fire.com)

4. Type: Automatic draining, ball check.

2.8 HOSE CONNECTIONS

A. Adjustable-Valve Hose Connections:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Fire Protection Products, Incorporated (www.fppi.com)
   c. Guardian Fire Equipment, Incorporated (www.guardianfire.com)
   d. Kidde Fire Fighting; A UTC Business Unit (www.kidde-fire.com)
   e. Tyco Fire & Building Products LP (tyco-fire.com)
   f. Zurn Industries, LLC (www.zurn.com)
2. Standard: UL 668 hose valve, with integral UL 1468 reducing or restricting pressure-control device, for connecting fire hose.
3. Pressure Rating: 300 psig minimum.
4. Material: Brass or bronze.
5. Size: NPS 1-1/2 or NPS 2-1/2, as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
8. Pattern: [Angle] [or] [gate].
9. Pressure-Control Device Type: Pressure [reducing] [restricting].
10. Design Outlet Pressure Setting: \<\text{Insert psig}\>.
11. Finish: [Polished chrome-plated] [Rough brass or bronze] [Rough chrome-plated].

B. Nonadjustable-Valve Hose Connections:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Fire Protection Products, Incorporated (www.fppi.com)
   c. Guardian Fire Equipment, Incorporated (www.guardianfire.com)
   d. Kidde Fire Fighting; A UTC Business Unit (www.kidde-fire.com)
   e. Tyco Fire & Building Products LP (tyco-fire.com)
   f. Zurn Industries, LLC (www.zurn.com)
2. Standard: UL 668 hose valve for connecting fire hose.
3. Pressure Rating: 300 psig minimum.
4. Material: Brass or bronze.
5. Size: NPS 1-1/2 or NPS 2-1/2, as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
8. Pattern: [Angle] [or] [gate].
9. Finish: [Polished chrome-plated] [Rough brass or bronze] [Rough chrome-plated].
2.9 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Globe Fire Sprinkler Corporation. (globe-sprinkler.com)
      b. Tyco Fire & Building Products LP. (tyco-fire.com)
      c. Victaulic Company. (www.victaulic.com)
      d. Viking Corporation. (www.vikingcorp.com)
      e. <Insert manufacturer's name>.
   2. Standard: UL 753.
   3. Type: Mechanically operated, with Pelton wheel.
   5. Size: 10-inch diameter.
   6. Components: Shaft length, bearings, and sleeve to suit wall construction.
   8. Outlet: NPS 1 drain connection.

C. Electrically Operated Alarm Bell:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Notifier; a Honeywell International Company. (www.notifier.com)
      c. Potter Electric Signal Company. (www.pottersignal.com)
   3. Type: Vibrating, metal alarm bell.
   5. Size: [6-inch minimum] [8-inch minimum] [10-inch] diameter.

D. Water-Flow Indicators:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ADT Security Services, Incorporated (www.adt.com)
      b. McDonnell & Miller; ITT Industries. (bellgossett.com)
      c. Potter Electric Signal Company. (www.pottersignal.com)
      d. System Sensor; a Honeywell company. (www.systemsensor.com)
      e. Viking Corporation. (www.vikingcorp.com)
      f. Watts (www.watts.com)
   4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
   5. Type: Paddle operated.
   7. Design Installation: Horizontal or vertical.

E. Pressure Switches:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Potter Electric Signal Company. (www.pottersignal.com)
b. System Sensor; a Honeywell company. ([www.systemsensor.com](http://www.systemsensor.com))
c. Tyco Fire & Building Products LP. ([tyco-fire.com](http://tyco-fire.com))
d. United Electric Controls Company ([www.ueonline.com](http://www.ueonline.com))
e. Viking Corporation. ([www.vikingcorp.com](http://www.vikingcorp.com))

3. Type: Electrically supervised water-flow switch with retard feature.
5. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Fire-Lite Alarms, Incorporated; a Honeywell company. ([www.firelite.com](http://www.firelite.com))
      b. Kennedy Valve; a division of McWane, Incorporated ([www.kennedyvalve.com](http://www.kennedyvalve.com))
      c. Potter Electric Signal Company. ([www.pottersignal.com](http://www.pottersignal.com))
      d. System Sensor; a Honeywell company. ([www.systemsensor.com](http://www.systemsensor.com))
   3. Type: Electrically supervised.
   5. Design: Signals that controlled valve is in other than fully open position.

G. Indicator-Post Supervisory Switches:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Potter Electric Signal Company. ([www.pottersignal.com](http://www.pottersignal.com))
      b. System Sensor; a Honeywell company. ([www.systemsensor.com](http://www.systemsensor.com))
      c. <Insert manufacturer's name>.
   3. Type: Electrically supervised.
   5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.10 MANUAL CONTROL STATIONS

A. Description: UL listed or FM approved, hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.11 CONTROL PANELS

A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
   1. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
   2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
   3. Manual Control Stations: Hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
2.12 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AMETEK; U.S. Gauge Division. (www.ametek.com)
   2. Ashcroft Incorporated (www.ashcroft.com)
   4. WIKA Instrument Corporation. (www.wika.us)

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0 to 250 psig minimum.

E. Pressure Gage Range: [0 to 250 psig minimum] [0 to 300 psig].

F. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

G. Air System Piping Gage: Include [retard feature and] "AIR" or "AIR/WATER" label on dial face.

PART 3 EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression standpipe piping to water-service piping at service entrance into building. Comply with requirements for exterior piping in Section 211100 "Facility Fire-Suppression Water-Service Piping."

B. Install shutoff valve, [backflow preventer,] pressure gage, drain, and other accessories at connection to fire-suppression water-service piping. [Comply with requirements for backflow preventers in Section 211100 "Facility Fire-Suppression Water-Service Piping."]

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 WATER-SUPPLY CONNECTIONS

A. Connect fire-suppression standpipe piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

B. Install shutoff valve, [backflow preventer,] pressure gage, drain, and other accessories at connection to water-distribution piping. [Comply with requirements for backflow preventers in Section 221119 "Domestic Water Piping Specialties."]
C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.5 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.

C. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.

D. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install drain valves on standpipes. Extend drain piping to outside of building.

F. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.

G. Install alarm devices in piping systems.

H. Install hangers and supports for standpipe system piping according to NFPA 14. Comply with requirements in NFPA 13 for hanger materials.

I. Install pressure gages on riser or feed main and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

J. Drain dry-type standpipe system piping.

K. Pressurize and check dry-type standpipe system piping and [air-pressure maintenance devices] [air compressors].

L. Fill wet-type standpipe system piping with water.

M. Install electric heating cables and pipe insulation on wet-type, fire-suppression standpipe piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 Section "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Division 21 Section "Fire-Suppression Systems Insulation."

N. Connect compressed-air supply to dry-pipe sprinkler piping.

O. Connect air compressor to the following piping and wiring:
   1. Pressure gages and controls.
   2. Electrical power system.
   3. Fire-alarm devices, including low-pressure alarm.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

### 3.6 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

E. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

F. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

G. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

H. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

### 3.7 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
3. Deluge Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
4. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
   a. Install air compressor and compressed-air supply piping.
   b. Air-Pressure Maintenance Device: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.
   c. Install compressed-air supply piping from building's compressed-air piping system.
3.8 HOSE-CONNECTION INSTALLATION
A. Install hose connections adjacent to standpipes.
B. Install freestanding hose connections for access and minimum passage restriction.
C. Install NPS 1-1/2 hose-connection valves with flow-restricting device.
D. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device.
E. Install wall-mounted-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Division 10 Section "Fire Extinguisher Cabinets."

3.9 HOSE-STATION INSTALLATION
A. Install freestanding hose stations for access and minimum passage restriction.
B. Install NPS 1-1/2 hose-station valves with flow-restricting device unless otherwise indicated.
C. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device unless otherwise indicated.
D. Install freestanding hose stations with support or bracket attached to standpipe.
E. Install wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Division 10 Section "Fire Extinguisher Cabinets."
F. Install hose-reel hose stations on wall with bracket.

3.10 FIRE-DEPARTMENT CONNECTION INSTALLATION
A. Install wall-type, fire-department connections.
B. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Division 03 Section "Cast-in-Place Concrete."
1. Install [two] [three] protective pipe bollards [around] [on sides of] each fire-department connection. Comply with requirements for bollards in Division 05 Section "Metal Fabrications."
C. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.11 IDENTIFICATION
A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14.
B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.12 FIELD QUALITY CONTROL
A. Perform tests and inspections.
B. Tests and Inspections:
1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Start and run air compressors.
6. Coordinate with fire-alarm tests. Operate as required.
7. Coordinate with fire-pump tests. Operate as required.
8. Verify that equipment hose threads are same as local fire-department equipment.

C. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.13 DEMONSTRATION

A. [Engage a factory-authorized service representative to train] [Train] Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.14 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with [threaded ends; cast-iron threaded fittings; and threaded] grooved ends; grooved-end fittings; and grooved joints.

B. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 4 and smaller <Insert pipe size range>, shall be one of the following:
   1. [Schedule 40] [or] [Schedule 30], black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. [Schedule 40] [Schedule 30] [or] [thinwall], galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   3. Standard-Weight, Schedule 30 or Schedule 10, black-steel pipe with cut-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   4. [Schedule 40] [or] [Schedule 30], galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   5. [Schedule 40] [or] [Schedule 30], black-steel pipe with plain ends; steel welding fittings; and welded joints.
   6. [Thinwall] [Schedule 10] [or] [lightwall] black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   7. [Thinwall] [Schedule 10] [or] [lightwall] black-steel pipe with plain ends; welding fittings; and welded joints.
   8. [Type L (Type B)] [Type M (Type C)], hard copper tube with plain ends; [cast-] [or] [wrought-]copper solder-joint fittings; and brazed joints.
   9. [Type L (Type B)] [Type M (Type B)], hard copper tube with roll-grooved ends; copper, grooved-end fittings; groove-end-tube couplings; and grooved joints.

C. Standard-pressure, wet-type, fire-suppression standpipe piping, [NPS 5 to NPS 8] <Insert pipe size range>, shall be [one of] the following:
   1. [Standard-weight] [Schedule 30] [or] [Thinwall], black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. [Standard-weight] [or] [Schedule 30], galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. [Standard-weight] [Or] [Schedule 30], black-steel pipe with [cut-] [or] [roll-] grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

4. [Standard-weight] [Or] [Schedule 30], galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

5. [Standard-weight] [Or] [Schedule 30], black-steel pipe with plain ends; steel welding fittings; and welded joints.

6. [Thinwall] [Schedule 10,] [Or] [Hybrid] black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

7. [Thinwall] [Schedule 10,] [Or] [Hybrid] black-steel pipe with plain ends; welding fittings; and welded joints.

8. [Type L] [Type M], hard copper tube with plain ends; [cast-] [or] [wrought-] copper solder-joint fittings; and brazed joints.

9. [Type L] [Type M], hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

D. Standard-pressure, wet-type, fire-suppression standpipe piping, [NPS 10 and NPS 12] <Insert pipe size range>, shall be [one of] the following:

1. [Standard-weight] [Or] [Schedule 30], black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

2. [Standard-weight] [Or] [Schedule 30], galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

3. [Standard-weight] [Or] [Schedule 30], black-steel pipe with [cut-] [or] [roll-] grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

4. [Standard-weight] [Or] [Schedule 30], galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

5. [Standard-weight] [Or] [Schedule 30], black-steel pipe with plain ends; steel welding fittings; and welded joints.

6. [Thinwall] [Schedule 10,] [Nonstandard OD, thinwall] [Or] [Hybrid] black-steel pipe with plain ends; welding fittings; and welded joints.

E. High-pressure, wet-type, fire-suppression standpipe piping, [NPS 4 and smaller] <Insert pipe size range>, shall be [one of] the following:

1. [Standard-weight] [Or] [Schedule 30], black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

2. [Standard-weight] [Or] [Schedule 30], galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

3. [Standard-weight] [Or] [Schedule 30], black-steel pipe with [cut] [cut- or roll] [roll]-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

4. [Standard-weight] [Or] [Schedule 30], galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

5. [Standard-weight] [Or] [Schedule 30], black-steel pipe with plain ends; steel welding fittings; and welded joints.

6. [Thinwall] [Schedule 10,] [Nonstandard OD, thinwall] [Or] [Hybrid] black-steel pipe with plain ends; welding fittings; and welded joints.

F. High-pressure, wet-type, fire-suppression standpipe piping, [NPS 5 and larger] <Insert pipe size range>, shall be [one of] the following:
1. [Standard-weight] [or] [Schedule 30], black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

2. [Standard-weight] [or] [Schedule 30], galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

3. [Standard-weight] [or] [Schedule 30], black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

4. [Standard-weight] [or] [Schedule 30], galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

5. [Standard-weight] [or] [Schedule 30], black-steel pipe with plain ends; steel welding fittings; and welded joints.

6. [Thinwall] [Schedule 10,] [Nonstandard OD, thinwall] [or] [Hybrid] black-steel pipe with plain ends; welding fittings; and welded joints.

G. Standard-pressure, dry-type, fire-suppression standpipe piping, [NPS 4 and smaller] <Insert pipe size range>, shall be one of the following:

1. [Standard-weight] [or] [Schedule 30], galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

2. [Standard-weight] [or] [Schedule 30], galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3. [Type L] [Type M], hard copper tube with plain ends; [cast-] [or] [wrought-] copper solder-joint fittings; and brazed joints.

4. [Type L] [Type M], hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

H. Standard-pressure, dry-type, fire-suppression standpipe piping, [NPS 5 and NPS 6] <Insert pipe size range>, shall be one of the following:

1. [Standard-weight] [or] [Schedule 30], galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

2. [Standard-weight] [or] [Schedule 30], galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3. [Type L] [Type M], hard copper tube with plain ends; [cast-] [or] [wrought-] copper solder-joint fittings; and brazed joints.

4. [Type L] [Type M], hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

END OF SECTION
SECTION 211313
WET-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Pipes, fittings, and specialties.
      2. Specialty valves.
      5. Control panels.
      6. Pressure gages.
   B. Related Sections:
      1. Section 211200 "Fire-Suppression Standpipes" for standpipe piping.
      2. Section 213113 "Electric-Drive, Centrifugal Fire Pumps" for fire pumps, pressure-maintenance pumps, and fire-pump controllers.
   C. Protection Limits:
      1. Provide 100 percent coverage for all new building areas, and all remodeled areas of the existing building.

1.3 DEFINITIONS
   A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.4 SYSTEM DESCRIPTIONS
   A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   B. Shop Drawings: For wet-pipe sprinkler systems.
      1. Include plans, elevations, sections, and attachment details.
      2. Include diagrams for power, signal, and control wiring.
   C. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Plumbing piping.
   2. Compressed air piping.
   3. HVAC equipment, sheetmetal and hydronic piping.
   4. Ceiling components
   5. Items penetrating finished ceiling include the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Audio/Visual devices
      d. Fire Alarm devices

B. Qualification Data: For qualified Installer and professional engineer.

C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
   1. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

D. Grooved joint couplings and fittings shall be referred to on drawings and product submittals and shall be identified by the manufacturer’s style or series designation. Trade names and abbreviations are not acceptable.

E. Fire-hydrant flow test report.

F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping.”

G. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.9 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer’s responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
B. All grooved joint couplings, fittings, valves, and specialties shall be of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
   1. All castings used for fittings, couplings, valve bodies, etc., shall include a cast date stamp for quality assurance and traceability.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."

1.10 PROJECT CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
   1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of sprinkler service.
   2. Do not proceed with interruption of sprinkler service without Owner's written permission.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   2. FM Global

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.
   1. Static and residual water pressure and water flow data shall be obtained from the local authority having jurisdiction.
   2. Minimum Pipe Sizes: Pipes shall not be smaller than sizes indicated on the drawings for connection to water supply piping, standpipes, and branches from standpipes to sprinklers.
   3. Maximum Water Velocity: Design water velocities shall not exceed 20 (FPS) feet per second in any fire protection piping.
   4. Sprinkler system design shall be approved by authorities having jurisdiction.
      a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
      b. Sprinkler Occupancy Hazard Classifications:
         1) Educational Areas: Light Hazard
         2) Office and Public Areas: Light Hazard
         3) Dressing Rooms: Light Hazard
         4) Audience Chamber Seating Area: Light Hazard
         5) Building Service Areas: Ordinary Hazard, Group 1
         6) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
         7) Dimmer rooms: Ordinary Hazard, Group 1.
         8) General Storage Areas: Ordinary Hazard, Group 1.
         9) Laundries: Ordinary Hazard, Group 1.
10) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
11) Receiving Dock: Ordinary Hazard, Group 1.
12) Audio Rack Rooms: Ordinary Hazard, Group 1.
14) Scene Shop: Ordinary Hazard, Group 2.
15) Scene Repair: Ordinary Hazard, Group 2.
16) Prop Shop: Ordinary Hazard, Group 2.
17) Spray Booth and Spray Booth Exhaust Duct: Extra Hazard Group 2
18) Dust Collector: Extra Hazard Group 2
19) Loading Dock: Ordinary Hazard, Group 2.
20) Stage: Ordinary Hazard, Group 2.
21) Studio Theater: Ordinary Hazard, Group 2.
22) Costume Lab / Costume Storage: Ordinary Hazard, Group 2.

5. Minimum Density for Automatic-Sprinkler Piping Design:
   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
   c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
   d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
   e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
   f. Special Occupancy Hazard: As determined by authorities having jurisdiction.

6. Maximum Protection Area per Sprinkler: According to UL listing.

7. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
   a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
   b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
   c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.

D. Spaces with Acoustic Reflectors
   1. In addition to other code requirements, in rooms containing acoustic reflectors or panels hung from structure, sprinklers may be required both in the panel and above in order to meet the requirements of NFPA 13. Provide coverage above and below the reflector as required by code and as necessary to meet aesthetic requirements.

2.2 PIPING MATERIALS
   A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.3 STEEL PIPE AND FITTINGS
   A. Standard Weight, Galvanized and Black Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
   B. Schedule 40, Galvanized- and Black-Steel Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M, Type E; or ASME B36.10M wrought steel.
   A. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
   C. Galvanized and Uncoated, Steel Couplings: ASTM A 865/A 865M, threaded.
F. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
   1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or EPDM rubber gasket.
      b. Class 150 and Class 300, Ductile-Iron or Steel, Raised-Face Flanges: Ring-type gaskets.
   2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

   1. Welding Filler Metals: Comply with AWS D10.12M/D10/12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Corcoran Piping System Co. (www.american-marsh.com)
      c. Shurjoint Piping Products. (www.shurjoint.com)
      d. Smith-Cooper International (www.smithcooper.com)
      e. Tyco Fire & Building Products LP. (tyco-fire.com)
      f. Victaulic Company. (www.victaulic.com)
   2. Pressure Rating: 175 psig minimum.
   4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and ASTM A449 bolts and nuts.
      a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with NFPA-13. Installation ready rigid coupling for direct stab installation without field disassembly. Couplings shall be fully installed at visual pad-to-pad offset contact. Tongue and recess type couplings, which require the use of a torque wrench to achieve the exact required gap between housings, are not permitted.
      b. Flexible Type: Use in locations where vibration attenuation and stress relief are required.

2.4 SPECIALTY VALVES
A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Alarm Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Victaulic Company (www.victaulic.com)
      b. Viking Corporation (www.vikingcorp.com)
   3. Design: For vertical installation.
4. Internal components shall be replaceable without removing the valve from the installed position.
5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application

G. Automatic (Ball Drip) Drain Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Reliable Automatic Sprinkler Co. Inc. (www.reliablesprinkler.com)
   b. Tyco Fire & Building Products (tyco-fire.com)
4. Type: Automatic draining, ball check.

H. Dry-Pipe Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Victaulic Company (www.victaulic.com)
   b. Viking Corporation (www.vikingcorp.com)
4. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
5. Required air pressure shall be 13-psi (90-kPa).
6. Valve shall be externally resettable.
7. Internal components shall be replaceable without removing the valve from the installed position.
8. Air-Pressure Maintenance Device:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Globe Fire Sprinkler Corporation (www.globesprinkler.com)
      2) Reliable Automatic Sprinkler Co., Inc. (www.reliablesprinkler.com)
      3) Tyco Fire & Building Products (tyco-fire.com)
      4) Venus Fire Protection Ltd (www.venus-fire.com)
      5) Victaulic Company (www.victaulic.com)
      6) Viking Corporation (www.vikingcorp.com)
   c. Type: Automatic device to maintain minimum air pressure in piping.
   d. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig outlet pressure.
9. Air Compressor:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Gast Manufacturing Inc. (www.gastmfg.com)
      2) General Air Products, Inc. (www.generalairproducts.com)
      3) Victaulic Company (www.victaulic.com)
      4) Viking Corporation (www.vikingcorp.com)
2.5 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the follow-
      ing:
      a. Anvil International (www.anvilintl.com)
      b. Shurjoint Piping Products (www.shurjoint.com)
      c. Tyco Fire & Building Products (tyco-fire.com)
      d. Victaulic Company (www.victaulic.com)
   5. Type: Mechanical-tee and -cross fittings.
   6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
   7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match
      connected branch piping.
   8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the fol-
      lowing:
      a. Reliable Automatic Sprinkler Co. Inc. (www.reliablesprinkler.com)
      b. Tyco Fire & Building Products (tyco-fire.com)
      c. Victaulic Company (www.victaulic.com)
   4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
   5. Size: Same as connected piping.
   6. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the fol-
      lowing:
      a. Elkhart Brass Manufacturing Co, Inc. (www.elkhartbrass.com)
      b. Fire-End & Croker Corporation (www.croker.com)
      c. Potter Roemer LLC (www.potterroemer.com)
   2. Standard: UL 199.
   5. Size: Same as connected piping.
   6. Inlet: Threaded.
   7. Drain Outlet: Threaded and capped.
   8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the fol-
      lowing:
      a. Victaulic Company (www.victaulic.com)
      b. Viking Corporation (www.vikingcorp.com)
   4. Body Material: Cast- or ductile-iron housing with sight glass.
   5. Size: Same as connected piping.
   6. Inlet and Outlet: Threaded.
E. Adjustable Drop Nipples:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Aegis Technologies, Inc. (aegistechnologiesinc.com)
      b. CECE, LLC (www.cecaforge.com)
      c. Corcoran Piping System Co.
      d. Merit Manufacturing
   5. Size: Same as connected piping.
   7. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Fivalco Inc. (www.fivalcoinc.com)
      b. FlexHead Industries, Inc. (www.flexhead.com)
      c. Gateway Tubing, Inc. (www.gatewaytubing.com)
      d. Victaulic Company (www.victualic.com)
   3. Type: Flexible hose for connection to sprinkler, and with open-gate bracket for connection to ceiling grid. The bracket shall allow installation before the ceiling tile is in place.
   5. Size: Same as connected piping, for sprinkler.
   6. The drop shall include a UL approved Series AH2 braided hose with a bend radius to 2” to allow for proper installation in confined spaces. The hose shall be listed for 4 bends at 31” length.
   7. Union joints shall be provided for ease of installation.

2.6 SPRINKLERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Reliable Automatic Sprinkler Co. Inc (www.reliablesprinkler.com)
   b. Victaulic Company (www.victualic.com)
   c. Viking Corporation (www.vikingcorp.com)
B. Sprinkler body shall be integrally cast with a hex shaped wrench boss to reduce the risk of damage during installation. Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss. (Sprinklers shall not contain rubber O-rings.)
C. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
D. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
E. Automatic Sprinklers with Heat-Responsive Element:
   1. Early-Suppression, Fast-Response Applications: UL 1767
   2. Nonresidential Applications: UL 199
   3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
F. Sprinkler Finishes:
   1. Refer to application schedule in Part 3.
G. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: One piece, flat with color to match adjacent surface.
2. Sidewall Mounting: One piece, flat with color to match adjacent surface.

H. Sprinkler Guards:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Tyco Fire & Building Products LP.
   c. Victaulic Company.
   d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

I. Guards and escutcheons shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.7 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. All flow and supervisory devices shall initiate a building alarm, and report the condition to Carleton Campus Security through the Fire Alarm Panel.

C. Electrically Operated Alarm Bell:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fire-Lite Alarms, Incorporated; a Honeywell company.
   b. Notifier; a Honeywell company.
   c. Potter Electric Signal Company.
3. Type: Vibrating, metal alarm bell.
4. Size: 6-inch minimum diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ADT Security Services, Incorporated.
   b. McDonnell & Miller; ITT Industries.
   c. Potter Electric Signal Company.
   d. System Sensor; a Honeywell company.
   e. Viking Corporation.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
7. Design Installation: Horizontal or vertical.

E. Pressure Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AFAC Incorporated.
b. Detroit Switch, Incorporated.
c. Potter Electric Signal Company.
d. System Sensor; a Honeywell company.
e. Tyco Fire & Building Products LP.
f. United Electric Controls Company
g. Viking Corporation.

3. Type: Electrically supervised water-flow switch with retard feature.
5. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Fire-Lite Alarms, Incorporated; a Honeywell company.
b. Kennedy Valve; a division of McWane, Incorporated.
c. Potter Electric Signal Company.
d. System Sensor; a Honeywell company.
3. Type: Electrically supervised.
5. Design: Signals that controlled valve is in other than fully open position.

G. Indicator-Post Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
b. System Sensor; a Honeywell company.
3. Type: Electrically supervised.
5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.8 CONTROL PANELS
A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
1. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.9 PRESSURE GAGES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AGF Manufacturing Inc. (www.testanddrain.com)
2. AMETEK, Inc. (www.ametek.com)
3. Ashcroft, Inc. (www.ashcroft.com)
4. Brecco Corporation
5. WIKI Instrument Corporation (www.wika.us)

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0- to 250-psig minimum.

E. Label: Include "WATER" label on dial face.

PART 3 EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

M. Fill sprinkler system piping with water.

N. Drain dry-pipe sprinkler piping.

O. Pressurize and check dry-pipe sprinkler system piping and air compressors.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

R. Route fire protection piping so that system and area zone drains are not exposed to view.

3.4 PIPE PENETRATIONS

A. Install sleeves for pipes passing through noise sensitive spaces:
   1. Penetrations by ducts, pipes and conduit between noise critical spaces shall be sleeved, packed and sealed airtight with non-hardening sealant as described herein. Refer also to other requirements in plans and specifications. Where information is duplicated, in conflict, complementary, etc. the more stringent acoustic requirements shall apply.

3.5 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints in accordance with the manufacturer’s published instructions. A factory trained representative (direct employee) shall provide on-site training for contractor’s field personnel in the use of grooving tools, application of groove, and product installation. The representative shall periodically visit the job site and review installation. Contractor shall remove and replace any improperly installed products.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.6 VALVE AND SPECIALTIES INSTALLATION

A. All flow and supervisory devices shall initiate a building alarm, and report the condition to Wayne State University Security through the Fire Alarm Panel.

B. Control valves shall be equipped with a port to monitor street side of system.

C. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

D. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

E. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

F. Specialty Valves:
   1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

G. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
   a. Install air compressor and compressed-air supply piping.
   b. Air-Pressure Maintenance Device: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.

3.7 SPRINKLER INSTALLATION

A. Sprinklers shall be located in a regular pattern, perpendicular and parallel with building lines, in perfect alignment with other ceiling components such as lights, air diffusers, grilles, and speakers.

B. Additional sprinklers (in excess of NFPA minimum requirements) may be required for aesthetics. Provide additional sprinklers heads located as directed by the Architect.
   1. Acoustical Ceiling Tile: Sprinklers shall be located in the center of tile; fully within a 4-inch diameter circle at the center of the tile. Locations shall be in the center of a 2-ft. x 2-ft. tile or in a 2 ft. x 2 ft. half of a 2 ft. x 4-ft. tile.
   2. Sprinklers shall be located no closer than 4 inches from any ceiling edge or from any other ceiling component.
   3. Sprinkler locations shall be reviewed and accepted by the Architect before any piping is fabricated or installed.
   4. Adjustments to sprinkler locations and number of sprinklers shall be anticipated during shop drawing review, and shall be allowed for in the Base Bid.
C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

D. Refer to theatrical drawings for additional information

E. Do not install sprinklers that have been dropped or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

F. Sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.

3.8 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 “Identification for Electrical Systems.”

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   4. Energize circuits to electrical equipment and devices.
   5. Coordinate with fire-alarm tests. Operate as required.
   6. Coordinate with fire-pump tests. Operate as required.
   7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.11 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
   1. Standard-weight or Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight or Schedule 40, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   3. Standard-weight or Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   4. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 8, shall be one of the following:
   1. Standard-weight or Schedule 40, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   2. Standard-weight or Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.

E. Standard-pressure, dry-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
   1. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

F. Standard-pressure, dry-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
   1. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.12 SPRINKLER SCHEDULE

A. Coordination
   1. Contractor shall submit layout drawing to architect for review & approval of locations prior to installation.
   2. Refer to architectural drawings, ceiling plans, and details for additional requirements for sprinkler system layout, sprinklers and details.
   3. Allow for 10% more heads than code minimum for flexibility in arrangement and pattern.

B. Use sprinkler types in subparagraphs below for the following applications:
   1. Rooms without Ceilings: Upright, rough bronze finish sprinklers in all areas where ceiling is not painted. Where exposed ceiling is painted, sprinkler finish shall be black or white to match painted ceiling.
   2. Rooms with Suspended Ceilings: Concealed sprinklers with factory-painted flush white or black cover plate to match suspended ceiling color.
   3. Provide sprinklers with concealed heads and flush cover plates in gypsum board ceilings: Color of cover plate to match adjacent ceiling color.
   4. Wall Mounting: Sidewall sprinkler with white or chrome plating in finished spaces exposed to view and rough bronze in unfinished spaces not exposed to view
   5. Rooms with Suspended or Floating Panels: Upright or pendant, manufacturer's white or black finish sprinklers for heads above panels; concealed sprinklers with custom ordered flush cover plate to match adjacent surface, color and texture for sprinklers in panels. Sprinklers above panels shall match painted ceiling color.
   6. Rooms with "Wood" Ceilings or Panels: Concealed sprinklers with custom ordered flush cover plate to match adjacent surface, color and texture.
   7. Rooms with vertical baffles: Pendant, rough bronze finish sprinklers located tight to baffles.

C. Wire guards shall be added to exposed sprinklers in the following locations: Scene Shop, Studio Theater Tension Grid Level, Theater Storage spaces, Circulation between Stage and Scene Shop, Mechanical and Electrical rooms, Telecomm Room, Costume Shop, Laundry, Paint Room, Tool Rooms, and Prop Shop.
   1. Where sprinklers have factory or custom finish, wire guards shall be painted to match sprinkler finish.
D. Use high temperature heads in rooms with performance lighting – Studio Theater Tension Grid Level and Stage.

END OF SECTION
SECTION 213113
ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Split-case fire pumps.
      2. Fire-pump accessories and specialties.

1.2 PERFORMANCE REQUIREMENTS
   A. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
   B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
      1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      2. Wiring Diagrams: For power, signal, and control wiring.
   C. Product Certificates: For each fire pump, from manufacturer.
   D. Source quality-control reports.
   E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For fire pumps to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.6 COORDINATION
   A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS
   A. Description: Factory-assembled and -tested fire-pump and driver unit.
   B. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
C. Finish: Red paint applied to factory-assembled and tested unit before shipping.

2.2 HORIZONTALLY MOUNTED, SINGLE-STAGE, SPLIT-CASE FIRE PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by the following but are not limited to, the following:
   1. A-C Fire Pump; a Xylem brand (acfirepump.com)
   2. Corcoran Piping Systems Co. (www.aadi.com)
   3. Patterson Pump Company; a Gorman-Rupp Company (www.pattersonpumps.com)
   4. Peerless Pump Company (www.peerlesspump.com)
   5. Reddy-Buffaloes Pump Company (www.listedfirepumps.com)
   6. S.A Armstrong Limited (www.armstrongfluidtechnology.com)

B. Pump:
   1. Standard: UL 448 for split-case pumps for fire service.
   3. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
   5. Shaft and Sleeve: Steel shaft with bronze sleeve.
      a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
      b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
   6. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.

C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

D. Driver:
   1. Standard: UL 1004A.
   2. Type: Electric motor; NEMA MG 1, polyphase Design B.

A. Capacities and Characteristics:
   1. Refer to equipment schedules.

2.3 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.

C. Relief Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following but are not limited to, the following:
      a. BERMAD Control Valves (www.bermad.com)
      b. CLA-VAL Automatic Control Valves (www.cla-val.com)
      c. Kunkle Valve (www.kunklevalve.pentair.com)
      d. OCV Control Valves (www.controlvalves.com)
      e. Watts; a Watts Water Technologies (www.wattswater.com)
      f. Zurn Industries, LLC (www.zurn.com)
   2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

F. Discharge Cone: Closed or open type.
G. Hose Valve Manifold Assembly:
   5. Manifold:
      a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
      b. Body: Exposed type, brass, with number of outlets required by NFPA 20.
      c. Escutcheon Plate: Brass or bronze; round.
      d. Exposed Parts Finish: Rough brass.
      e. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.4 GROUT
B. Characteristics: Nonshrink and recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.5 SOURCE QUALITY CONTROL
A. Testing: Test and inspect fire pumps according to UL 448 requirements for “Operation Test” and “Manufacturing and Production Tests.”
   1. Verification of Performance: Rate fire pumps according to UL 448.
B. Fire pumps will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.
B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES
A. Install concrete bases of dimensions indicated for fire pumps, pressure-maintenance pumps, and controllers. Refer to Division 21 Section “Common Work Results for Fire Suppression.”

3.3 INSTALLATION
A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
B. Equipment Mounting:
1. Install fire pumps on cast-in-place concrete equipment bases.

C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

D. Support piping and pumps separately so weight of piping does not rest on pumps.

E. Install valves that are same size as connecting piping.

F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings.

G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.

H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.4 ALIGNMENT

A. Align split-case pump and driver shafts per industry standards after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

E. Align vertically mounted, split-case pump and driver shafts after complete unit has been made plumb on concrete base, grout has set, and anchor bolts have been tightened.

3.5 CONNECTIONS

A. Comply with requirements for piping and valves specified in "Wet-Pipe Sprinkler Systems." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect water supply and discharge piping to fire pumps with flexible connectors. Connect water supply and discharge piping to pressure-maintenance pumps with flexible connectors. Refer to Division 21 Section "Water-Based Fire-Suppression Systems" for flexible connectors.

D. Connect relief-valve discharge to point of disposal.

E. Connect controllers to pumps.

F. Connect fire-pump controllers to building fire-alarm system. Refer to Division 28 Section "Fire Detection and Alarm."

G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
3.6 IDENTIFICATION
A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.7 FIELD QUALITY CONTROL
A. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Section 213900 "Controllers for Fire-Pump Drivers."
B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
D. Tests and Inspections:
   1. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
   2. Test according to NFPA 20 for acceptance and performance testing.
   3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
E. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
F. Prepare test and inspection reports.
G. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.8 STARTUP SERVICE
A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.9 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION
SECTION 213400
PRESSURE-MAINTENANCE PUMPS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Vertical-turbine, pressure-maintenance pumps.
B. Related Section:
   1. Division 21 "Controllers for Fire-Pump Drivers" for pressure-maintenance-pump controllers.

1.3 PERFORMANCE REQUIREMENTS
A. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.

1.4 SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings: For pumps, accessories, and specialties. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For pumps to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided

PART 2 PRODUCTS

2.1 VERTICAL-TURBINE, PRESSURE-MAINTENANCE PUMPS
A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   1. A-C Fire Pump; a Xylem brand (www.acfirepump.com)
   2. Patterson Pump Company; a Gorman-Rupp Company (www.pattersonpumps.com)
   3. Peerless Pump Company (www.peerlesspump.com)
4. Pentair Pump Group (www.pentair.com)
5. Reddy-Buffaloes Pump Company (www.listedfirepumps.com)
6. Ruhrpumpen, Inc. (www.ruhrpumpen.com)
7. S.A Armstrong Limited (www.armstrongfluidtechnology.com)
8. Sulzer Pumps Inc. (www.sulzer)

B. Description: Factory-assembled and -tested, vertical, multistage, open-line-shaft turbine pump as defined in HI 2.1-2.2 and HI 2.3; with pump motor mounted above pump head.

C. Pump Construction:
   1. Pump Head: Cast iron, for surface discharge, with flange except connections may be threaded in sizes in which flanges are not available.
   2. Pump Head Seal: Stuffing box and stuffing.
   3. Line Shaft: Stainless steel or steel, with corrosion-resistant shaft sleeves.
   4. Line Shaft Bearings: Rubber sleeve, water lubricated.
   5. Line Shaft: Steel.
   7. Impeller Shaft: Monel metal or stainless steel.
   8. Bowl Section: Multiple cast-iron bowls with closed-type bronze or stainless-steel impellers.
   9. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel fittings, in sections 10 feet or less, with strainer of cast or fabricated bronze or stainless steel at bottom.

   1. Power Cord: Factory-connected to motor for field connection to controller and at least 10 feet long.

E. Base: Cast iron or steel with hole for electrical cable.

F. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

A. Capacities and Characteristics:
   1. Refer to equipment schedules.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 21 "Common Motor Requirements for Fire Suppression Equipment."
   1. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

A. NFPA Standard: Comply with NFPA 20 for installation of pressure-maintenance pumps.

B. Base-Mounted Pump Mounting: Install pumps on concrete bases.

C. Install vertical-turbine, pressure-maintenance pumps according to HI 2.4.
3.2 **FIELD QUALITY CONTROL**

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pressure-maintenance pumps will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.3 **ADJUSTING**

A. Lubricate pumps as recommended by manufacturer.

B. Set field-adjustable pressure-switch ranges as indicated.

**END OF SECTION**
PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contact, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Controllers for diesel-drive fire pumps.
      2. Controllers for pressure-maintenance pumps.

1.3 DEFINITIONS
   A. ATS: Automatic transfer switch(es).
   B. ECM: Electronic control module.
   C. MCCB: Molded-case circuit breaker.
   D. N.O.: Normally open.
   E. PID: Proportional integral derivative.
   F. VFC: Variable-frequency controller(s)

1.4 SUBMITTALS
   A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   B. Shop Drawings: For each type of product indicated. Include dimensioned plans, elevations, sections, details, and attachments to other work, including required clearances and service spaces around controller enclosures.
      1. Show tabulations of the following:
         a. Each installed unit's type and details.
         b. Enclosure types and details for types other than NEMA 250, Type 2.
         c. Factory-installed devices.
         d. Nameplate legends.
         e. Short-circuit current (withstand) rating of integrated unit.
         f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
      2. Detail equipment assemblies and indicate dimensions, weights, loads, method of field assembly, components, and location and size of each field connection.
      3. Schematic and Connection Diagrams: For power, signal, alarm, and control wiring and for pressure-sensing tubing.
   C. Product Certificates: For each type of product indicated, from manufacturer.
   D. Manufacturer's factory test reports of fully assembled and tested equipment.
   E. Source quality-control reports.
F. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product indicated to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
   2. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor-based logic controls.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.
B. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Comply with standards of authorities having jurisdiction pertaining to materials and installation.
E. Comply with NFPA 20 and NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.8 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Ambient Temperature Rating: Not less than 40 deg F and not exceeding 122 deg F unless otherwise indicated.
   2. Altitude Rating: Not exceeding 6600 feet unless otherwise indicated.
B. Interruption of Existing Electric Service: Notify Architect and Owner no fewer than seven days in advance of proposed interruption of electric service, and comply with NFPA 70E.

1.9 COORDINATION

A. Coordinate layout and installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.
B. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.1 FULL-SERVICE CONTROLLERS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   1. Firetrol
   2. Aquarius Fluid Products, Inc. (www.shopping.netsuite.com)
3. ASCO Power Technologies, LP; a business of Emerson Network Power (www.asco.com)
4. Eaton (www.eaton.com)
5. Hubbell Incorporated (www.hubbell-wiring.com)
6. Joslyn Clark Corporation (www.danaherspecialtyproducts.com)
7. Master Control Systems, Inc. (www.mastercontrols.com)
9. Tornatech (www.tornatech.com)

B. General Requirements for Full-Service Controllers:
1. Comply with NFPA 20 and UL 218.
2. Listed by an NRTL for electric-motor driver for fire-pump service.
3. Combined automatic and non-automatic operation.
4. Factory assembled, wired, and tested; continuous-duty rated.
5. Service Equipment Label: NRTL labeled for use as service equipment.

C. Method of Starting:
1. Pressure-switch actuated.
   a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
   b. System pressure recorder, electric ac driven, with spring backup.
   c. Programmable minimum-run-time relay to prevent short cycling.
   d. Programmable timer for weekly tests.
3. Solid-State Controller: Reduced-voltage type.
4. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.

D. Method of Stopping: Non-automatic.

E. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.

F. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and non-thermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.

G. Door-Mounted Operator Interface and Controls:
1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:
   a. Microprocessor-based logic controller, with multilane digital readout.
   b. Membrane keypad.
   c. LED alarm and status indicating lights.
3. Local and Remote Alarm and Status Indications:
   a. Controller power on.
   b. Motor running condition.
   c. Loss-of-line power.
   d. Line-power phase reversal.
   e. Line-power single-phase condition.
4. Audible alarm, with silence push button.
5. Non-automatic START and STOP push buttons or switches.

H. Optional Features:
1. Extra Output Contacts:
   a. One N.O. contact(s) for motor running condition.
   b. One set(s) of contacts for loss-of-line power.
c. One each, Form C contacts for high and low reservoir level.
2. Local alarm bell.
3. Door-mounted thermal or impact printer for alarm and status logs.

I. ATS:
1. Complies with NFPA 20, UL 218, and UL 1008.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
6. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with non-thermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
7. Local and Remote Alarm and Status Indications:
   a. Normal source available.
   b. Alternate source available.
   c. In normal position.
   d. In alternate position.
   e. Isolating means open.
8. Audible alarm, with silence push button.
10. Engine test push button.
11. Start generator output contacts.
12. Timer for weekly generator tests.

2.2 CONTROLLERS FOR PRESSURE-MAINTENANCE PUMPS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   1. Aquarius Fluid Products, Inc. (www.shopping.netsuite.com)
   2. ASCO Power Technologies, LP; a business of Emerson Network Power (www.asco.com)
   3. Eaton (www.eaton.com)
   4. Hubbell Incorporated (www.hubbell-wiring.com)
   5. Joslyn Clark Corporation (www.danaherspecialtyproducts.com)
   8. Tornatech (www.tornatech.com)

B. General Requirements for Pressure-Maintenance-Pump Controllers:
   1. Type: UL 508 factory assembled, wired, and tested, across-the-line; for combined automatic and manual operation.
   2. Enclosure: UL 508 and NEMA 250, Type 2 for wall-mounting.
   3. Factory assembled, wired, and tested.
   4. Finish: Manufacturer's standard color paint.

C. Rate controller for scheduled horsepower and include the following:
   1. Fusible disconnect switch.
   2. Pressure switch.
   4. Pilot light.
5. Running period timer.

2.3 REMOTE ALARM PANELS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   1. Aquarius Fluid Products, Inc. (www.shopping.netsuite.com)
   2. ASCO Power Technologies, LP; a business of Emerson Network Power (www.asco.com)
   3. Eaton (www.eaton.com)
   4. Hubbell Incorporated (www.hubbell-wiring.com)
   5. Joslyn Clark Corporation (www.danaherspecialtyproducts.com)
   8. Tornatech (www.tornatech.com)

B. General Requirements for Remote Alarm Panels: Factory assembled, wired, and tested.

C. Supervisory and Normal Control Voltage: 120-V ac single source.

D. Audible and Visual Alarm and Status Indications:
   1. Driver running.
   2. Loss of phase.
   3. Phase reversal.
   4. Supervised power on.
   5. Separate trouble on the controller.
   6. Controller connected to alternate power source.

E. Audible and Visual Alarm and Status Indications: Manufacturer's standard indicating lights; non-push-to-test, with separate test push button.
   1. Unit running.
   2. Controller main switch turned to the off or manual position.
   3. Supervised power on.
   4. Separate trouble on the controller.
   5. Common pump room trouble.
   6. Controller connected to alternate power source.

F. Audible alarm, with silence push button.

G. Pump REMOTE START push button.

2.4 ENCLOSURES

A. Fire-Pump Controllers, ATS, Remote Alarm Panels, and Low-Suction-Shutdown Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.
   1. Indoor, Dry and Clean Locations: Type 1 (IEC IP10)
   2. Indoor Locations Subject to Dripping Noncorrosive Liquids: Type 2 (IEC IP11).
   3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12 (IEC IP12).

B. Enclosure Color: Manufacturer's standard "fire-pump-controller red".

C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.

D. Optional Features:
   1. Floor stands, 12 inches high, for floor-mounted controllers.
   2. Space heater, 120-V ac with thermostat.
2.5 SOURCE QUALITY CONTROL
A. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and UL 218.
   1. Verification of Performance: Rate controllers according to operation of functions and features specified.
B. Fire-pump controllers will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine areas and surfaces to receive equipment, with Installer present, for compliance with re-
   quirements and other conditions affecting performance.
B. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROLLER INSTALLATION
A. Install controllers within sight of their respective drivers.
B. Connect controllers to their dedicated pressure-sensing lines.
C. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than 79 inches above finished floor, and bottom of enclosure not less than 12 inches above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 “Hangers and Supports for Electrical Systems.”
D. Floor-Mounting Controllers: Install controllers on 4-inch nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches above finished floor.
E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
F. Comply with NEMA ICS 15.

3.3 REMOTE ALARM PANEL INSTALLATION
A. Install panels on walls with tops not higher than 72 inches above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Division 26 “Hangers and Supports for Electrical Systems.”

3.4 POWER WIRING INSTALLATION
A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Division 26 "Low-Voltage Electrical Power Conductors and Cables."
3.5 CONTROL AND ALARM WIRING INSTALLATION

A. Install wiring between controllers and remote devices and facility's central monitoring system. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."

A. Install wiring between remote alarm and low-suction-shutdown panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Division 26 "Control-Voltage Electrical Power Cables."

B. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Division 28 "Digital, Addressable Fire-Alarm System."

C. Bundle, train, and support wiring in enclosures.

D. Connect remote manual and automatic activation devices where applicable.

3.6 IDENTIFICATION

A. Comply with requirements in NFPA 20 for marking fire-pump controllers.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Division 26 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:

1. Inspect and Test Each Component:
   a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
   b. Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
   c. Test continuity of each circuit.

2. Verify and Test Each Electric-Driver Controller:
   a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify Architect before starting the motor(s).
   b. Test each motor for proper phase rotation.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Field Acceptance Tests:

1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to Architect and authorities having jurisdiction.

2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
3. Engage manufacturer's factory-authorized service representative to be present during the testing.
4. Perform field acceptance tests as outlined in NFPA 20.
F. Controllers will be considered defective if they do not pass tests and inspections.
G. Prepare test and inspection reports.

3.8 STARTUP SERVICE
A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer’s written instructions.

3.9 ADJUSTING
A. Adjust controllers to function smoothly and as recommended by manufacturer.
B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.
C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
D. Set field-adjustable pressure switches.

3.10 PROTECTION
A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.11 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controllers, remote alarm panels, and to use and reprogram microprocessor-based controls within this equipment.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Design Development
      1. Documents: Design development specifications may include plumbing and HVAC equipment not required for this project. Equipment and capacities are identified on the drawings. Refer to the specifications for equipment characteristics, components, accessories, and installation requirements. These documents are not for construction.
   B. GMP pricing documents: This is a preliminary copy of the contract documents. The documents (drawings and project manual) are incomplete and issued to present the design intent. Equipment, material, and labor required to provide complete operating systems shall be included in the GMP.
   C. This Section includes the following:
      1. Excavating and backfilling for pipe trenches.
      2. Piping materials and installation instructions common to most piping systems.
      3. Transition fittings.
      4. Dielectric fittings.
      5. Grout.
      6. Plumbing demolition.
      7. Equipment installation requirements common to equipment sections.
      8. Painting and finishing.
      9. Concrete bases.
     10. Supports and anchorages.

1.3 BASIS-OF-DESIGN
   A. Equipment manufacturers listed on the equipment schedules are the basis-of-design. Manufactures listed in the specification other than the basis-of design manufacture are acceptable substitutions. Equipment schedules are on the drawings. Refer to specifications for unscheduled equipment.

1.4 DEFINITIONS
   A. GMP: Guaranteed Maximum Price
   B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
   C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
   D. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
E. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

F. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

G. The following are industry abbreviations for plastic materials:
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

H. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Equipment Startup Reports.

C. Coordination Drawings: Submit one copy for the engineers use. Division 22 coordination drawings will not be returned.
   1. Detail major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
      a. Planned piping layout, including valve and specialty locations and valve-stem movement.
      b. Clearances for installing and maintaining insulation.
      c. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
      d. Equipment and accessory service connections and support details
      e. Exterior wall and foundation penetrations.
      f. Fire- and smoke-rated wall and floor penetration.
      g. Sizes and locations of required concrete equipment curbs and bases.
      h. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
      i. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
      j. Access door and panel locations.
      k. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

D. Pre-demolition test reports.
1.7 QUALITY ASSURANCE

A. Comply with ASHRAE Guideline 4 – 2008 Preparation of operating and maintenance documentation for building systems.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

E. Equipment Substitutions: Equipment of greater capacity or of greater physical size or weight may be furnished provided such proposed equipment is approved in writing. Approval will require that any necessary structural modifications are made, any connecting mechanical and electrical services are increased, and if accommodations can be made in the allocated space. No additional costs will be approved for any changes necessary to provide the larger equipment.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate plumbing equipment installation with other building components.

E. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

F. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate connection of plumbing equipment and systems with building electrical systems.
1.10 GUIDELINES, CODES AND STANDARDS
   A. Refer to the most recently published edition for references to guidelines, and standards (examples: ASHRAE, NFPA, AWWA, ASTM) unless a specific edition is listed.
   B. Installation and materials shall comply with applicable national, state, and local codes and ordinances.

2.1 NOISE SENSITIVE SPACES
   A. Penetrations by ducts, pipes and conduit between noise sensitive spaces shall be sleeved, packed and sealed airtight with non-hardening sealant as described herein. Refer also to other requirements in plans and specifications. Where information is duplicated, in conflict, complementary, etc. the more stringent acoustic requirements shall apply.

PART 2 PRODUCTS

2.2 MANUFACTURERS
   A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.3 PIPE, TUBE, AND FITTINGS
   A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
   B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.4 JOINING MATERIALS
   A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
   B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
      1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
         a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
         b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
      2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
   C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
   D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
   E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
   F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
   G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
H. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D 2235.
   2. CPVC Piping: ASTM F 493.
   3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   4. PVC to ABS Piping Transition: ASTM D 3138.

2.5 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Company
      b. Dresser Industries, Incorporated; DMD Division
      c. Ford Meter Box Company, Incorporated (The); Pipe Products Division
      d. JCM Industries
      e. Smith-Blair, Incorporated
      f. Viking Johnson.
   2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
   4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Eslon Thermostatics

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Thompson Plastics, Incorporated

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Manufacturers:
      a. NIBCO Incorporated
      b. NIBCO, Incorporated; Chemtrol Division

E. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve ends same size as piping to be joined, and corrosion-resistant metal band on each end.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Company
      b. Fernco, Incorporated
      c. Mission Rubber Company
      d. Plastic Oddities, Incorporated

2.6 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.
C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Manufacturers:
      a. Capitol Manufacturing Company
      b. Central Plastics Company.
      c. Epco Sales, Incorporated
      d. Watts Industries, Incorporated; Water Products Division

D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Manufacturers:
      a. Advance Products & Systems, Incorporated
      b. Calpico, Incorporated
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Incorporated
   2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Calpico, Incorporated
      b. Lochinvar Corporation.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Perfection Corporation.
      b. Precision Plumbing Products, Incorporated
      c. Sioux Chief Manufacturing Company, Incorporated
      d. Victaulic Company of America.

2.7 GROUT
A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 TRENCHING AND BACKFILLING
A. Refer to civil drawings and specifications for trenching and backfilling within the building.

3.2 PLUMBING DEMOLITION
A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.4 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

J. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Non-pressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D 3138 Appendix.

K. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

L. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

M. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

N. PEX Piping Joints: Join according to ASTM F 1807.

O. Steel-Piping Grooved Joints: Roll groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

P. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in steel piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric flanges to connect piping materials of dissimilar metals.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install plumbing equipment according to the equipment manufacturer’s installation instructions and as indicated on the drawings. Resolve conflicting instructions, with the architect before mounting equipment.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment to allow right of way for piping installed at required slope.

F. Refer to equipment shop drawings for rough-in locations; do not scale drawings.

3.7 PRODUCT INSTALLATION

A. Manufacturer’s instructions:
   1. Except where more stringent requirements are indicated, comply with the product manufacturer’s instructions and recommendations.
   2. Consult with manufacturer’s technical representatives, who are recognized as technical experts, for specific instructions on special projects conditions.
   3. If conflict exists, notify the Owner’s in writing and obtain his instruction before proceeding with the work in question.

B. Movement of Equipment:
   1. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed.
   2. Otherwise, advise Contractor of opening requirements to be maintained for the subsequent entry of equipment.

C. Clearances:
   1. Install Piping:
      a. Straight and true.
      b. Aligned with other work.
      c. Close to walls and overhead structure (allowing for insulation).
      d. Concealed, where possible, in occupied spaces.
      e. Out-of-the-way with maximum passageway and headroom remaining in each space.
   2. Do not obstruct windows, doors and other openings.
   3. Coordinate location of piping systems required to slope for drainage (over other service lines and ductwork).

D. Access:
   1. Provide for removal, without damage to other parts, of plumbing systems.
   2. Connect equipment for ease of disconnecting with minimum of interference with other work.
   3. Provide unions where required.
   4. Locate operating and control equipment and devices for easy access.
   5. Provide access panels where equipment or devices are concealed by non-accessible finishes and similar work.
3.8 CLOSING-IN OF UN-INSPECTED WORK
A. Do not allow or cause any work to be covered up or enclosed until inspected, tested and approved.
B. Should any work be enclosed or covered up before such inspection and test, Contractor shall, at his/her own expense, uncover work and after it has been inspected, tested and approved, make repairs with such materials as necessary to restore his/her work and that of other Divisions to original and proper condition.

3.9 PAINTING
A. Painting of plumbing systems, equipment, and components is specified in architectural drawings and specifications.
B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.10 CONCRETE BASES
A. Concrete Bases and Curbs:
   1. Provide scaled layouts of bases and curbs with sizes and locations dimensioned to concrete walls and columns.
   2. Determine base and curb sizes and locations based on “Accepted” equipment shop drawings. Base and curb sizes shall not be scaled from the Drawings.
   3. Anchor equipment to concrete base according to equipment manufacturer’s written instructions and according to acoustic requirements at Project.
B. Construction Details:
   1. Provide concrete bases sized 4 inches larger in both directions than the supported equipment.
   2. Provide 4-inch high curbs and bases with finished edges, unless otherwise indicated.
   3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   6. Install anchor bolts to elevations required for proper attachment to supported equipment.
   7. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   8. Use 3000-psi, 28-day compressive-strength concrete and reinforcement.
   9. Chamfer all outside corners of concrete bases and curbs.

3.11 ERECTION OF METAL SUPPORTS AND ANCHORAGES
A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
C. Field Welding: Comply with AWS D1.1.

3.12 ERECTION OF WOOD SUPPORTS AND ANCHORAGES
A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.13 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.14 SEALANTS


3.15 CYBERSECURITY RISK MITIGATION STRATEGY

A. Coordinate with Owner’s IT Department to restrict external network access to Internet connected system through virtual private network (VPN) connections only.

B. Security Event Log: Coordinate with the Owner to configure security event logging. Access to security logs shall be limited to users with proper authentication. Security logs shall be time stamped with Time and Date metadata for auditing and back-up.

C. Disable any protocols for remote connectivity, unless constantly required for day-to-day operations.

D. All external transport data shall be routed through encrypted channels with 2048-bit secure sockets layer (SSL).

E. Coordinate with Owner’s IT Department to implement a Web server-based human machine interface (HMI) that relies on IT technologies to secure access and restrict ports that can be opened on the firewall. Coordinate with Owner’s IT Department to restrict access to known IP addresses only.

F. Where building system networks are not physically separate from IT business networks, coordinate with Owner’s IT Department to segregate networked and Internet connected systems from the IT business network using virtual local area network (VLAN) IT technologies to restrict internal attacks/breakdowns.

G. Set unique, cryptographically strong passwords for administrator and user accounts. Default passwords must be changed before systems are connected to the Owner’s network.

H. Collect only the data that is necessary for analytics and optimization.

I. References:
3.16 PRELIMINARY OPERATION
A. The Owner's Representative reserves the right to operate portions of the mechanical system on a preliminary basis without voiding the guarantee or relieving the Contractor of his/her responsibilities.

3.17 OPERATIONAL TESTS
A. Before operational tests are performed, demonstrate to the Owner's Representative that systems and components are complete and fully charged with operating fluid and lubricants. Systems shall be operable and capable of maintaining continuous uninterrupted operation during the operating and demonstration period.
B. After systems have been completely installed, connections made, and tests completed, operate the systems continuously for a period of five working days during the hours of a normal working day.
C. Rotating equipment shall be in dynamic balance and alignment.
D. Tests required in various sections herein shall be completed.
E. Notify the Owner's Representative, in writing, two weeks in advance of this operational period.
F. This operational test may be concurrent with instruction of the Owner's operating personnel.

3.18 COMPLIANCE TESTS
A. Conduct tests for individual components of all portions of the installation as may be required by the various Sections of this Division to comply with the Contract Documents. Tests shall be made in the presence of the Owner's Representative. Costs of tests shall be borne by the Contractor. Contractor shall provide all instruments, equipment, labor and materials to complete the tests. These tests may be required at any time between the installation of the work and the end of the warranty period. Should these tests expose any defective materials, poor workmanship or variance with requirements of Contract Documents, Contractor shall make any changes necessary and remedy any defects at no cost to the Owner.

END OF SECTION
SECTION 220502 - BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Where contradictions occur between this Section and Division 01, the most stringent of the two shall apply. Architect shall decide which is most stringent.
B. These Basic Requirements apply to the entire Division 22 work.
C. All referenced and related provisions of Divisions 21, 23 and 26 shall also apply to the work of this section as if fully repeated herein.
D. Building systems commissioning: An independent third party Commissioning Agent will document completion of the Plumbing, HVAC, and Electrical Systems for the project. The Construction Manager, Division Contractors, and Test and Balance Contractor are members of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to other sections for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team.

1.2 SUMMARY
A. The definitions of Division 01 and the General Conditions of the Specification also apply to the Division 22 contract.
B. “Contract Documents” constitute the drawings, specifications, general conditions, project manuals, etc., prepared by engineer (or other design professional in association with Engineer) for contractor’s bid or contractor’s negotiations with the Owner. The Division 22 drawings and specifications prepared by the Engineer are not Construction Documents.
C. “Construction Documents”, “construction drawings”, and similar terms for Division 22 work refer to installation diagrams, shop drawings and coordination drawings prepared by the contractor using the design intent indicated on the Engineer’s contract documents. These specifications detail the contractor’s responsibility for “Engineering by Contractor” and for preparation of construction documents.
D. “Install” means to “set in place, connect and place in full operational order”.
   1. “Provide” means to “furnish and install”.
E. “Equal” or “Equivalent” means “meets the specifications of the referenced product or item in all significant aspects”. Significant aspects shall be as determined by the Owner’s Representative.
F. “Work by other(s) divisions”, “re: Division”, and similar expressions means work to be performed under the contract documents, but not necessarily under the division or section of the work on which the note appears. It is the contractors’ sole responsibility to coordinate the work of the contract between his/her suppliers, subcontractors and employees. If clarification is required, consult Owner’s Representative before submitting bid.
G. By inference, any reference to a “contractor” or “sub-contractor” means the entity, which has contracted with the Owner for the work of the Contract Documents.
H. “Engineer” means the design professional firm, which has preferred these contract documents. All questions, submittals, etc. of this division shall be routed to the Engineer (through proper contractual channels).
1.3 COORDINATION WITHIN DIVISION 22

A. Contract Documents:
   1. General: The Contract Documents are diagrammatic showing certain physical relationships, which must be established within Division 22 work and its interface with other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing dimensions, clearances or material quantities.
   2. Supplemental Instructions: The exact location for some items in this Specification may not be shown on the Drawings. The location of such items may be established by the Owner’s Representative during the progress of the work.
   3. Discrepancies:
      a. Examine Drawings and Specifications of all Divisions of the work.
      b. Report any discrepancies to the Owner’s Representative and obtain written instructions before proceeding.
      c. Should there be a conflict within or between the Specifications or Drawings, the most stringent or higher quality requirements shall apply.
      d. Items called for either in the Specifications or on the Drawings shall be required as if called for in both.
   4. Constructability:
      a. Examine Drawings and Specifications of all Divisions of the work.
      b. Report any issues to the Owner’s Representative which may prevent installation of Division 22 work in accordance with the Contract Documents and the original construction contract.

B. Contractor shall be responsible for providing proper documentation of equipment product data and shop drawings to all entities providing service.

C. Coordination Drawings: Prepare coordination drawings in accordance with Division 01, Section “Submittals” to scale of 1/4” = 1'-0" or larger, detailing major elements, components, and systems of mechanical equipment (i.e. equipment rooms, and exterior equipment areas) and materials in relationship with other system, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important to the efficient flow of the work, including (but not necessarily limited to) the following:
   1. Indicate all major piping (HVAC, Plumbing and Fire Suppression), electrical equipment and conduits, structural, and architectural elements in these areas as well.
   2. Sizes and locations of required concrete pads, piers, curbs, and bases.
   3. Provide all necessary sections and elements for clarification.
   4. Indicate all seismic restraint and support systems to be used for all mechanical equipment throughout the project.
   5. Ductwork and piping transitions from rooftop units to shafts or horizontal ducts.
   6. Failure to produce or submit coordination drawings does not dismiss the Contractor’s responsibility for translating the design intent of the Contract Documents into Construction Drawings.

D. Deferred Approval Items: Division 01.

E. Utility Connections:
   1. Coordinate the connection of plumbing system with utilities and services.
   2. Comply with regulations of utility suppliers.
   3. The contract documents indicate the available information on existing utilities and services, and on new services (if any) to be provided to the project by utility companies and agencies.
      a. Notify the Owner’s Representative immediately if discrepancies are found.
   4. Coordinate mechanical utility interruptions one week in advance in writing with the Owner’s Representative and the Utility Company.
      a. Plan work so that duration of the interruption is kept to a minimum.
1.4 COORDINATION WITH OTHER DIVISIONS

A. General:
   1. Coordinate the Division 22 work with the progress of the work of the other trades.
   2. Complete the entire installation as soon as the condition of the building will permit.
   3. Contractor is responsible for coordination of his/her work with Owner’s facility staff engaged in
      building automation, commissioning of systems, fire alarm system, etc.

B. Chases, Inserts and Openings:
   1. Provide measurements, drawings, and layouts so that opening, inserts and chases in new
      construction can be built and coordinated as construction progresses.
   2. Check sizes and locations of openings provided.
   3. Any cutting and patching made necessary by failure to provide measurements, drawings, and
      layouts at the proper time shall be done at no additional cost to the Owner.

C. Support Dimensions: Provide dimensions and drawings so that concrete bases and other
   equipment supports to be provided under other Sections of the Specifications can be built at the
   proper time.

D. Deferred Approved Items: Division 01.

1.5 ENGINEERING BY CONTRACTOR

A. The construction of this building requires the Contractor to design several systems or subsystems.
   All such designs shall be the complete responsibility of the Contractor.

B. Systems or subsystems which require responsibility by the Contractor and submitted to the
   Engineer for review include, but are not limited to:
   1. Equipment and piping supports, not detailed in the drawings.
   2. Pipe hangers and anchors not specified in these documents, or catalogued by the
      manufacturer.
   4. Thermal pipe stress analysis.

1.6 REGULATORY REQUIREMENTS

A. General:
   1. Regulatory Compliance: Work performed under this Division shall comply with the latest
      currently adopted editions of Codes and Regulations including, but not limited to those listed
      below.
   2. Minimum Requirements: The requirements of the Drawings and Specifications are the
      minimum that will be allowed, unless such requirements are exceeded by applicable codes or
      Regulations, in which case the Code or Regulation requirement shall govern.
   3. Code Changes: Should a code change occur between time of proposal and date of permit
      issue, and the Contractor has unnecessarily delayed the acquisition of permits, the contractor
      shall hold the Owner free from additional expense resulting from such Code change.

B. Codes: Comply With the Currently Adopted (At Time of Contract Award) Codes

C. Comply With the Latest Editions of Applicable Regulations and Standards, Including:
   1. Uniform Plumbing Code
   3. Underwriter’s Laboratories, Inc. (UL).
   6. American Society of Mechanical Engineers (ASME).
9. Compressed Gas Association (CGA).
13. Plumbing and Drainage Institute (PDI).
15. Factory Mutual Standards

D. Requirements of Local Utility Companies: Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment, which will be required for the project.

E. Additional Regulations: Follow additional regulations which appear in individual Sections of these Specifications.

F. Contradictions: Where codes are contradictory, follow the most stringent, unless otherwise indicated in Plans or Specifications. The Owner’s Representative shall determine which is most stringent.

G. Contract Documents Not in Compliance:
   1. Where it is not noted that the Drawings and Specifications do not comply with the minimum requirements of the codes, either notify the Owner’s Representative in writing during the Bidding Period of the revisions required to meet Code Requirements. After entering into contract, Contractor will be held to complete all work necessary to meet Code Requirements without additional expense to the Owner.
   2. Follow Drawings and Specifications where they are superior to Code Requirements.

H. Permits:
   1. Contractor shall pay for and obtain all permits required by authorities and agencies having jurisdiction for the work in this Division.
   2. Post permits as required.

I. Inspections and Tests:
   1. Arrange for all required inspections and tests.
   2. Pay all charges.
   3. Notify the Owner’s Representative in writing 72 hours before tests.
   4. Submit one copy for Owners record of permits. Licenses, inspection reports and test reports.

1.7 EQUIVALENTS AND SUBSTITUTIONS

A. The applicable paragraphs for General Requirements, Division 01 apply herein.

B. Basis for Design: The manufacturer’s name and product listed on the drawings, or listed first of several names in these Specifications, is used as a basis for design to establish space requirements, a standard of quality and performance.

C. Equivalents: Products of one or more other manufacturer’s names listed in these Specifications following the words “or equivalent by” may be selected, subject to paragraph below titled “Contractor’s Responsibility for Equivalent and Substitutions.”

D. Other Options:
   1. For products specified by naming only one manufacturer, refer to paragraph below under “Substitutions”.
   2. For products specified only by performance characteristics or reference standards, select any manufacturer meeting the requirements.
E. Substitutions: Requests for acceptance of a product of manufacturer’s name not listed in these specifications will be considered if any one of the following conditions is met:
1. The named product is not available because of strikes or discontinuance of manufacture, and the proposed product is equivalent to the named product.
2. The proposed product is superior to the named product, in the opinion of the Owner’s representative.
3. The proposed product is equivalent to the named product and its use will be to the advantage of the Owner, by the Owner receiving an equitable credit or cost savings. The Owner’s Representative reserves the right to reject any substitution.
4. Submit proposed substitutions with bid along with alternate price, complete descriptive data and a comparison of the substitute manufacturer’s product with specified product. Request for acceptance of a product of manufacturer’s name not listed in these specifications, is subject to the paragraph titled “Contractor’s Responsibility Equivalents and Substitutions”.

F. Contractor’s Responsibility for Equivalents and Substitutions:
1. Items submitted as a substitution to the basis of design or listed general equivalents shall be identified as such and shall include a written request for substitution indicating the following:
   b. Contract time adjustment.
   c. Item by item breakdown of differences between basis of design and substituted item.
   d. Operation, maintenance and energy cost difference.
2. Products of manufacturer must match the features, construction, performance and size of those selected for design. Standard catalogued may require certain modifications to meet specified requirements.
3. The responsibility for providing that specified requirements have been met remains with the manufacturer and contractor. Should the substituted item fail to perform in accordance with the Specifications, replace same with the originally specified item without extra cost to the contract.
4. When requesting review of an equivalent or substituted product, submit a comparison chart listing features, construction, performance and sizes of named product versus equivalent or substituted product.
5. Submittals for review of an equivalent or substituted product will be reviewed for acceptability when all the above requirements have been met. Contractor shall be responsible for all costs incurred by the Architect and Engineer for review of equivalency beyond initial review.
6. Coordinate the installation of the product with all trades.
7. Contractor shall be responsible for changes in electric wiring, materials and for all other additional costs of construction by all trades involved to accommodate the product to perform same as product used on the “Basis of Design”.
8. Coordination of General Equivalents and Substitutions: Where Contract Documents permit selection from general equivalents, or where substitutions are authorized, coordinate clearance and other interface requirements with mechanical and other work.
9. Provide necessary additional items so that selected or substituted item operates equivalent to the Basis of Design and properly fits in the available space allocated for the Basis of Design.
10. Contractor is responsible for assuring that piping, conduit, duct, flue and other service locations for general equivalents or substitutions do not cause access, service or operational difficulties any greater than would be encountered with the Basis of Design.
11. Failure to comply with these requirements will result in immediate rejection of the request for substitution.

1.8 GENERAL SUBMITTAL REQUIREMENTS
A. Refer to Division 01.
B. Coordination and Sequencing:
1. Coordinate submittals 3 weeks (minimum) prior to expected order date so that work will not be delayed by submittals.
2. Do not submit product data, or allow its use on the project until compliance, with requirement of Contract Documents has been confirmed by Contractor.
3. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
4. Submitting contractor is responsible for routing reviewed submittals to all parties affected including but not limited to electrical, building automation and temperature control, and test and balance subcontractors.
5. Make submittals for group of similar products or materials such as valves, fixtures, pumps, insulation, etc., or area of work complete and at one time, not in piecemeal fashion.
6. Identify submittals with Architect’s project name and number, with item designation as indicated on drawings, and referenced to applicable paragraphs of the specifications. Submit in brochure form.
7. Submittals of products needed at start of Project for its installation, or those requiring a long lead time for assembly or manufacturing, should be submitted before the others.

C. Preparations of Submittals:
1. Refer to Division 01 requirements.
2. Provide permanent marking on each submittal to identify project, date, Contractor, Subcontractor, Supplier, submittal name and similar information to distinguish it from other submittals.
3. Indicate any portions of work, which deviate from the Contract Documents.
   a. Explain the reasons for the deviations.
   b. Show how such deviations coordinate with interfacing portions of other work.
4. Show Contractor’s executed review and approval marking.
5. Provide space for the Owner’s Representative “Action” marking.
6. Submittals, which are received from sources other than through Contractor’s office, will be returned “Without Action”.
7. Submittals shall be presented in a neat and legible fashion and shall be returned “Without Action” if presented in any other fashion.

D. Response to Submittals: Where standard product data has been submitted, it is recognized:
1. That the Submitter has determined that the products fulfill the specified requirements.
2. That the submittal is for the Owner’s Representative information only, but will be returned with appropriate action where observed to be not in compliance with the requirements.

E. If more than two submittals (either for shop drawings, as-builts drawings, or test and balance reports) are made by the contractor due to the incompleteness, non-compliance, errors, omissions, etc. the Owner reserves the right to charge the contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

1.9 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS
A. Manufacturer’s Data:
1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black ink to indicate which of the variations is to be provided.
2. Delete or mark-put significant portions of pre-printed data, which are not applicable.
3. Where operating ranges are shown, mark data to show portion of range required for project application.
4. For Each Product, Include the Following:
   a. Sizes.
   b. Weights.
c. Speeds.
d. Capacities.
e. Piping and electrical connection sizes and locations.
f. Statements of compliance with the required standards and regulations.
g. Performance data.

1.10 COMPATIBILITY

A. General: Provide products, which are compatible with other products of the mechanical work, and with other work, requiring interface with the mechanical work.

B. Power Characteristics: Where power characteristics are not stated in Division 22 Sections, refer to the Sections of Division 26 and the Electrical Drawings for the power characteristics of each power driven item of mechanical equipment. Coordinate available power with Electrical Contractor before ordering equipment. Mechanical Contractor shall be responsible for ordering equipment to meet the available power characteristics. If there is a conflict between Division 22 documents and Division 26 documents, provide a written notification to the Owner’s Representative for direction. Do not order equipment prior to determining the proper electrical service. No contract cost adjustment will be allowed for equipment ordered in conflict with the available power characteristics.

1.11 RECORD DRAWINGS

A. Drawings:
1. Record of Project Progress: Purchase from the Architect a complete set of reproducible contract drawings and maintain drawings available at the job site for inspection. Keep an accurate, legible and continuously updated record of installed locations and all project revisions other than revised drawings issued by the Architect, including source and date of authorization. Utilize only contract drawing symbols for recording the work. Drawing notations to be sufficiently clear in the representation of the work, for utilization by a CADD operator (drafts person) who is not necessarily familiar with the installed work.
2. Record of Installation: At the conclusion of the work, deliver one (1) set of blue prints of the progress drawings to the Owner’s Representative for review. Following the review, Contractor shall have incorporated by a competent CADD operator all of the installed data represented on the project progress drawings.

3. Include in Record Drawings the Following:
   a. Revisions, including sketches, bulletins, change orders, written addenda and directives, clarifications and responses generated by requests for information (RFIs), regardless of source of the revision.
   b. Location and configuration of equipment with related housekeeping pads.
   c. Location of fixtures, drains and appurtenances.
   d. Physical routing of piping, underground, exposed, and above ceiling with locations of valves and accessories plainly marked and identified.
   e. Location of piping below building and on exterior, valves, manholes, appurtenances and stub outs dimensioned from buildings and permanent structures, both horizontally and vertically.
   f. Location of wall and ceiling access panels.

B. Acceptance: As a condition for acceptance of the work, deliver two (2) sets of Auto CAD Latest Version CDs and one set of signed and dated reproducible drawings to the Owner’s Representative and obtain a receipt.

1.12 OPERATING AND MAINTENANCE DATA

A. Refer to Division 01 requirements.

B. Submission:
   1. Submit three typed and bound copies of Operating and Maintenance (O&M) Manuals prior to scheduling systems demonstrations for the Owner’s Representative, as specified in Division 01.
   2. Bind each Maintenance Manual in one or more vinyl covered, 3-ring binders, with pockets for folded drawings.
      a. Mark the spine of each binder with system identification and volume number.

C. Required Contents:
   1. Manuals shall have index with tab dividers for each major equipment section to facilitate locating information on a specific piece of equipment.
   2. Identify data within each section with drawing code numbers as they appear on Drawings and Specifications. Include as a minimum the following data:
      a. Alphabetical list of system components, with the name, address and 24 hour telephone number of the company responsible for servicing each item during the first year of operation. Include point of contact for company.
      b. Operating instructions for complete system including:
         1) Emergency procedures for fire and failure of major equipment.
         2) Major start, operation and shut down procedures.
      c. Maintenance Instructions for Each Piece of Equipment Including:
         1) Equipment lists.
         2) Proper lubricants and lubricating instructions for each piece of equipment.
         3) Necessary cleaning, replacement and/or adjustment schedule.
         4) Product data.
         5) Installation instructions.
         6) Parts list.
      d. Marked or changed prints locating concealed parts and variations from the original system design (as-built drawings).
      e. Valve schedule and associated piping schematics. See Section 220553, IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT.
f. Copies of any extended equipment warranties which are greater than one year.

1.13 WARRANTIES
A. The warranty period is two years after Date of Acceptance:
   1. During this period, provide labor and materials as required to repair or replace defects in the mechanical system at no additional cost to the Owner. Provide certificate with O&M Manual submittal, which guarantees same-day service response to Owners call for all such warranty service.
   2. Provide certificate for such items of equipment, which have warranties in excess of one year. Insert copies in O&M Manuals.
   3. Provide extended manufacturers warranties to cover two years from date of acceptance if standard warranty starts any time prior to that date.
   4. At time of bid, submit additional costs or extended warranties for principal equipment (e.g. point of use water heaters, pumps, air compressor, etc.).
B. Provide longer warranties where specified in individual specification sections.
C. Refer to Division 01 for additional requirements.

1.14 SPARE PARTS, SPECIAL TOOLS
A. Deliver spare parts to the Owner’s Representative and obtain receipts at the time operating instructions are given to the Owner’s personnel.
B. Include the Following:
   1. V-Belts: One complete set of each size.
   2. Fuses: each type used for all equipment utilizing fuses. Quantity 10%, but not less than two.
   3. Pilot Light Lamps: Each type used on the project. Quantity of 10%, but not less than two.
   4. Special Tools: Furnish special tools required for assembly, adjustment, setting or maintenance of equipment if such tool is not readily available on the commercial tool market.
   5. Maintenance Paint: Furnish one can of touch-up paint for each different factory finish, which is to be the final finished surface of the product.
   6. Alternate Parts: Under the individual mechanical sections, there are listed spare parts to be furnished under a bid alternate. Should the alternate be accepted, such spare parts shall be similarly delivered to the Owner.

1.15 SYSTEM ACCEPTANCE
A. Acceptance shall be contingent upon completion of final review and correction of all deficiencies. Satisfactory completion of the operational tests, which shall demonstrate compliance with all performance criteria, and the requirements of the Contract Documents.
B. Request a Final Review Prior to System Acceptance After Completion of the Following:
   1. Installation of all systems required by Contract Documents.
   2. Submission and acceptance of service manuals.
   3. Identification.
   4. Cleaning.
   5. Satisfactory operation of all systems for a period of one week.

1.16 MANDATORY GOVERNING PROVISION
A. Omissions of words or phrases, such as “the Contractor shall”, in conformity with”, “shall be”, “as noted on the Drawings”, “according to the Drawings”, “an”, “the”, and “all” are intentional.
B. Omitted words or phrases shall be supplied by inference.
1.17 OWNER FURNISHED EQUIPMENT
A. All equipment called out in the Specifications or shown on the Drawings as “Owner Furnished Equipment” shall be installed and connected under this contract. Provide rough-ins for all future connections indicated, unless otherwise specifically indicated on Drawings.

1.18 TEMPORARY FACILITIES
A. Light, heat, power, etc.
   1. Contractor shall be responsible for providing temporary electricity, heat and other facilities as specified in Division 01.
   2. Contractor shall be responsible for maintaining the equipment in an as-new condition. Equipment will not be turned over to the Owner until it is brought up to as-new condition.

1.19 SAFETY PROVISIONS
A. Equipment Nameplates: provide power-oriented plumbing equipment with a permanent nameplate attached by the manufacturer, indicating:
   1. The manufacturer.
   2. Product name.
   3. Model number.
   4. Serial number.
   5. Speed.
   6. Capacity.
   7. Power characteristics.
   8. Labels of testing, or inspecting agencies.
   9. Other similar data.

B. Where manufacturer affixed nameplate is not available, Contractor shall fabricate and attach nameplate.

C. Guards:
   1. Unless equivalent guards are provided integral with the equipment, enclose each belt drive (including sheaves) on both sides in a galvanized, one inch, mesh screen of No. 18 gauge steel wire or expanded metal, fastened to an approved, structural steel frame, securely fastened to the equipment or floor.
   2. Provide tachometer holes at shaft centers. Unless equivalent guards are provided integral with the equipment, install a solid guard of No. 20 gauge galvanized steel over the coupling of each item of direct-driven equipment.
   3. Sides are not required on these guards except to ensure rigidity.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 INSTALLATION GENERAL REQUIREMENTS
A. Furnish, apply, install, connect, erect, clean, and condition manufactured materials and equipment as recommended in manufacturer’s printed directions (maintained on job site during installation).

B. Provide all attachment devices and materials necessary to secure materials together or to other materials.

C. Make allowance for ample and normal expansion and contraction for all building components and piping systems that are subject to such.
D. Install materials only when conditions of temperature, moisture, humidity and conditions of adjacent building components are conducive to achieving the best installation results.

E. Erect, install and secure components in a structurally sound and appropriate manner.

F. Where necessary, temporarily brace, shore, or otherwise support members until final connections are installed.

G. Leave all temporary bracing, shoring, or other structural supports in place as long as practical for safety and to maintain proper alignment.

H. Handle materials in a manner to prevent scratching, abrading, distortion, chipping, breaking, or other disfigurement.

I. Conduct work in a manner to avoid injury or damage to previously placed work.

J. Any work so impaired or damaged shall be replaced at no expense to Owner.

K. Fabricate and install materials true to line, plumb and level.

L. Leave finished surfaces smooth and flat, free from wrinkles, wraps, scratches, dents and other imperfections.

M. Furnish materials in longest practical lengths and largest practical sizes to avoid all unnecessary jointing.

N. Make all joints secure, tightly fitted, and as inconspicuous as possible by the best, accepted practice in joinery and fabrication.

O. Consult the Owner’s Representative for mounting height or position of any unit not specifically indicated or located on Drawings or specified in Specifications.

P. Job mixed multi-component materials used in the work shall be mixed in such regulated and properly sized batches that material can be used before it begins to “set”.

Q. Mixing of a partially “set” batch with another batch of fresh materials will not be accepted and entire batch shall be discarded and removed from site.

R. Clean all mixing tools and appliances that can be contaminated prior to mixing of fresh materials.

S. In addition to the above, refer to each Section of the Specifications for additional installation requirements for the proper completion of all work.

3.2 COORDINATION OF PLUMBING INSTALLATION

A. Inspection and Preparation:
   1. Examine the work interfacing with plumbing work, and the conditions under which the work will be performed, and notify the Owner’s Representative of conditions detrimental to the proper completion of the work at original contract price.
   2. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Layout:
   1. Layout the plumbing work in conformity with the Contract Drawings, Coordination Drawings and other Shop Drawings, product data and similar requirements so that the entire plumbing system will perform as an integrated system, properly interfaced with other work recognizing that portions of the work are shown only in diagrammatic form.
   2. Where coordination requirements conflict with individual system requirements, comply with the Owner’s Representative decision on resolution of the conflict.
   3. Take necessary field measurements to determine space and connection requirements.
   4. Provide sizes and shapes of equipment so the final installation conforms to the intent of the Contract Documents.
5. Provide necessary fittings to create offsets as required to coordinate with building structure and other trades, even if fittings are not shown on the Contract Drawings.

C. Integrate plumbing work in ceiling spaces with the ceiling suspension system, light fixtures and other work, so that required performance of each will be achieved.

3.3 PRODUCT INSTALLATION

A. Manufacturer’s instructions:
   1. Except where more stringent requirements are indicated, comply with the product manufacturer’s instructions and recommendations.
   2. Consult with manufacturer’s technical representatives, who are recognized as technical experts, for specific instructions on special projects conditions.
   3. If conflict exists, notify the Owner’s in writing and obtain his instruction before proceeding with the work in question.

B. Movement of Equipment:
   1. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed.
   2. Otherwise, advise Contractor of opening requirements to be maintained for the subsequent entry of equipment.

C. Heavy Equipment:
   1. Coordinate the movement of heavy items with shoring and bracing so that the building structure will not be overloaded during the movement and installation.
   2. Where plumbing products to be installed on the existing roof are too heavy to be hand-carried, do not transport across the existing roof deck. Position by crane or other device so as to avoid overloading or otherwise damaging the roof deck.

D. Clearances:
   1. Install Piping:
      a. Straight and true.
      b. Aligned with other work.
      c. Close to walls and overhead structure (allowing for insulation).
      d. Concealed, where possible, in occupied spaces.
      e. Out-of-the-way with maximum passageway and headroom remaining in each space.
   2. Do not obstruct windows, doors and other openings.
   3. Coordinate location of piping systems required to slope for drainage (over other service lines and ductwork).

E. Access:
   1. Provide For Removal, Without Damage To Other Parts, Of:
      a. Seals.
      b. Shafts.
      c. Gaskets.
      d. Drives.
      e. Filters.
      f. Strainers.
      g. Bearings.
      h. Control components.
      i. Other parts requiring periodic replacement or maintenance.
   2. Connect equipment for ease of disconnecting with minimum of interference with other work.
   3. Provide unions where required.
   4. Locate operating and control equipment and devices for easy access.
5. Provide access panels where equipment or devices are concealed by non-accessible finishes and similar work.

6. Ensure grease fittings for equipment are readily visible and accessible. Extend fittings when necessary.

3.4 EQUIPMENT SERVICE ACCESS AND MAINTAINABILITY

A. A "maintenance access" zone (vertically and horizontally) is to be defined and called out on coordination and shopdrawings and maintained through final construction. The maintenance access zone shall match the manufacturer’s recommendations and shall extend from the top of the unit or equipment to the finished floor without obstruction other than removable ceiling tile or moveable furnishings.

1. Coordination with architectural, mechanical, electrical, fire protection and plumbing equipment is required; no service access shall be blocked.

B. Accessible equipment is defined as:

1. Being capable of being reached without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformer, piping, ductwork, light fixture, structural members, conduits, fixed equipment, casework, and fixed furnishings.

2. Maximum access height of equipment:
   a. For equipment above lay-in ceilings: No more than 4’ above ceiling grid or an absolute maximum of 14’ above the finished floor.
   b. For equipment above hard ceilings, provide minimum 24”x24” access panel. Locate equipment no more than 4’ above ceiling height.

3. Equipment requiring service access shall include but not be limited to:
   a. Control valves
   b. Isolation Valves
   c. Sensors, switches and other control devices or instrumentation
   d. Motors
   e. Pumps
   f. Air bleeders or air vents
   g. Strainers
   h. Heat exchangers
   i. Meters

4. Pull space for coils and heat exchanger tube bundles needs to be defined and shown on plans and equipment elevation views. Isolation valves need to be located outside the coil pull space to allow for removal without draining down the entire system.

3.5 PROTECTION OF WORK

A. Provide protection against dust migration, rain, wind, storms, frost, or heat, so as to maintain all work, materials, apparatus and fixtures free from injury or damage.

B. At end of each day’s work, cover all new work likely to be damaged.

C. Do not interrupt the integrity of the building security overnight.

D. Refer to Division 01 for additional requirements.

E. All pipe ends, valves and equipment left unconnected shall be capped, plugged or otherwise properly protected to prevent damage and the intrusion of foreign matter.

F. Any equipment or piping systems found to have been damaged or contaminated above "MILL" or "SHOP" conditions shall be replaced or cleaned to the Owner’s Representative satisfaction.

G. Provide initial water seal fill for all waste P-traps or similar traps.
3.6 PROTECTION OF POTABLE WATER SYSTEMS
A. All temporary water connections shall be made with an approved back flow preventer.
B. All hose bibs shall have as a minimum, a vacuum breaker, to prevent back flow.
C. Direct connections to hydronic systems shall only be made through a reduced pressure back flow preventer.

3.7 OBJECTIONABLE NOISE AND VIBRATION
A. Mechanical equipment and piping system shall operate without objectionable noise and vibration, as determined by the judgment of the Owner’s Representative.
B. If objectionable noise and vibration should be produced, make necessary changes or additions required to produce satisfactory result without additional cost to the Owner.

3.8 CLOSING-IN OF UN-INSPECTED WORK
A. Do not allow or cause any work to be covered up or enclosed until inspected, tested and approved.
B. Should any work be enclosed or covered up before such inspection and test, Contractor shall, at his/her own expense, uncover work and after it has been inspected, tested and approved, make repairs with such materials as necessary to restore his/her work and that of other Divisions to original and proper condition.

3.9 CLEANING
A. After installation is complete, clean all systems as indicated below.
B. Piping and Equipment To Be Insulated: Clean exterior thoroughly to remove rust, plaster, cement and dirt before insulation is applied.
C. Piping and Equipment Remain Un-insulated: Clean exterior thoroughly to remove rust, plaster, cement, dirt and other foreign substances.
D. Piping and Equipment To Be Painted: Clean exterior to be exposed in completed structure. Remove rust, plaster, cement and dirt by wire brushing. Remove grease, oil and other foreign materials by wiping with clean rags and suitable solvents.
E. During Progress of Work: Carefully clean up the premises and keep all portions of the building free of debris.
F. Chrome Or Nickel Plated Work: Thoroughly polish.

3.10 DAMAGE RESPONSIBILITY
A. Contractor shall be responsible for damage to the grounds, buildings or equipment and the loss of refrigerants, fuels or gases, caused by leaks or breaks in pipes for equipment furnished or installed under this Division.

3.11 PRELIMINARY OPERATION
A. The Owner’s Representative reserves the right to operate portions of the mechanical system on a preliminary basis without voiding the guarantee or relieving the Contractor of his/her responsibilities.
3.12 OPERATIONAL TESTS

A. Before operational tests are performed, demonstrate to the Owner’s Representative that systems and components are complete and fully charged with operating fluid and lubricants. Systems shall be operable and capable of maintaining continuous uninterrupted operation during the operating and demonstration period.

B. After systems have been completely installed, connections made, and tests completed, operate the systems continuously for a period of five working days during the hours of a normal working day.

C. Rotating equipment shall be in dynamic balance and alignment.

D. Tests required in various sections herein shall be completed.

E. Notify the Owner’s Representative, in writing, two weeks in advance of this operational period.

F. This operational test may be concurrent with instruction of the Owner’s operating personnel.

3.13 COMPLIANCE TESTS

A. Conduct tests for individual components, such as chiller, boiler, cooling tower, air handling unit, etc. of all portions of the installation as may be required by the various Sections of this Division to comply with the Contract Documents. Tests shall be made in the presence of the Owner’s Representative. Costs of tests shall be borne by the Contractor. Contractor shall provide all instruments, equipment, labor and materials to complete the tests. These tests may be required at any time between the installation of the work and the end of the warranty period. Should these tests expose any defective materials, poor workmanship or variance with requirements of Contract Documents, Contractor shall make any changes necessary and remedy any defects at no cost to the Owner.

END OF SECTION
SECTION 220513
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer’s factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION
A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS
A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.
B. Comply with NEMA MG 1 unless otherwise indicated.
C. All motors controlled by variable speed controllers shall be equipped with a shaft grounding ring.

2.2 MOTOR CHARACTERISTICS
A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS
A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Premium efficient, as defined in NEMA MG 1.
C. Service Factor: 1.15.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.
D. Multispeed Motors: Separate winding for each speed.
F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
G. Temperature Rise: Match insulation rating.
H. Insulation: Class F.
I. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer’s standard starting characteristic.
J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
K. Shaft grounding ring: Provide circumferential conduct micro fiber shaft grounding ring.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS
A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   5. Shaft grounding ring: Provide circumferential conduct micro fiber shaft grounding ring.
C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS
A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.
B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
D. Motors 1/20 HP and Smaller: Shaded-pole type.
E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 EXECUTION

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.0 SLEEVES
A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.1 SLEEVE-SEAL SYSTEMS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.
B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.
2.2 SLEEVE-SEAL FITTINGS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Holdrite.
B. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping OD.

2.3 GROUT
B. Characteristics: Non-shrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION
A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes in walls.
C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas, pipe chases, or other wet areas 2 inches above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in "Joint Sealants."
E. Fire-BARRIER Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements for fire stopping specified in "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION
A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

END OF SECTION
SECTION 220518
ESCUTCHEONS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions
      and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Escutcheons.
      2. Floor plates.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 ESCUTCHEONS
   A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew
      fastener One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish
      and spring-clip fasteners.
   B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
   C. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed
      hinge and setscrew.
   D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed
      hinge and setscrew.
   E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge,
      and spring-clip fasteners.

2.2 FLOOR PLATES
   A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
   B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 EXECUTION

3.1 INSTALLATION
   A. Install escutcheons for exposed piping penetrations of walls, ceilings, and finished floors.
   B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that
      completely covers opening.
      1. Escutcheons for New Piping:
         a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

c. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

d. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

e. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

2. Escutcheons for Existing Piping in Renovated Areas:
   a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
   b. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.
   2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION
SECTION 220519
METERS AND GAGES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Light-activated thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
B. Related Sections:

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of meter and gage, from manufacturer.

1.4 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 LIGHT-ACTIVATED THERMOMETERS
A. Direct-Mounted, Light-Activated Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ashcroft
      b. Marshaltown
      c. Taylor
      d. Trerice, H. O. Company
      e. Weiss Instruments, Incorporated
   2. Case: Plastic 9-inch nominal size unless otherwise indicated.
   3. Scale(s): Degrees F and degrees C.
   6. Stem: Aluminum and of length to suit installation.
      a. Design for Thermowell Installation: Bare stem.
   8. Accuracy: Plus or minus 1 degree F.

2.2 THERMOWELLS
A. Thermowells:
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES or CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: [Mixture of graphite and glycerin] <Insert material>.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ashcroft
      b. Marshaltown
      c. Taylor
      d. Trerice, H. O. Company
      e. Weiss Instruments, Incorporated
   3. Case Open-front, pressure relief type(s); cast aluminum or drawn steel; 3-1/2-inch dimension nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
   10. Ring: Metal.
   11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Valves: Brass ball NPS 1/4, ASME B1.20.1 pipe threads.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.
D. Fill thermowells with heat-transfer medium.
E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install thermometers in the following locations:
   1. Domestic hot water service connection to the new addition / theater.
   2. Outlet of each recirculation pump.

I. Install pressure gages in the following locations:
   1. Building water service entrance into building.
   2. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS
   A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING
   A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE
   A. Thermometers at domestic hot water service connection to the addition shall be the following:
      1. Direct-mounted, light-activated type.
   B. Thermometers at inlet and outlet of each domestic water heater shall be the following:
      1. Direct-mounted, light-activated type.
   C. Thermometers at inlets and outlets of each domestic water heat exchanger shall be the following:
      1. Direct-mounted, light-activated type.
   D. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be the following:
      1. Direct-mounted, light-activated type.
   E. Thermometers at outlet of each recirculation pump shall be the following:
      1. Direct-mounted, light-activated type.
   F. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE
   A. Scale Range: 0 degrees F. to 140 degrees F.

3.6 PRESSURE-GAGE SCHEDULE
   A. Pressure gages at discharge of each water service into building shall be one of the following:
      1. Open-front, pressure relief type, direct-mounted, metal case.
   B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
      1. Open-front, pressure relief type, direct-mounted, metal case
   C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
      1. Open-front, pressure relief type, direct-mounted, metal case.
3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 160 psi.

END OF SECTION
SECTION 220523
BALL VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Bronze ball valves.
   2. Chainwheels

1.3 DEFINITIONS
A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of valve indicated.
   1. Certification that products comply with NSF 61 Annex G.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand-wheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES
A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.5 for flanges on steel valves.
   4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   6. ASME B31.9 for building services piping valves.

B. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

C. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

D. Valve Sizes: Same as upstream piping unless otherwise indicated.

E. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
   2. Handlever: For quarter-turn valves smaller than NPS 4.

F. Valves in Insulated Piping:
   1. Include 2-inch stem extensions.
   2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
   3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; Conbraco Industries, Inc. (www.apollovalves.com)
      b. Crane; Crane Energy Flow Solutions (www.cranecpe.com)
      c. FNW; Ferguson Enterprises, Inc. (www.fnw.com)
      d. Hammond Valve (www.hammondvalve.com)
      e. Lance Valves (lancevalves.com)
      f. Milwaukee Valve Company. (www.milwaukeevalve.com)
      g. NIBCO Incorporated (www.nibco.com)
      h. Watts; a Watts Water Technologies Company (www.watts.com)
      i. Zurn Industries, LLC (www.zurn.com)
   2. Description:
      b. CWP Rating: 600 psig.
      c. Body Design: Two piece.
      d. Body Material: Bronze.
      e. Ends: Threaded or soldered.
      f. Seats: PTFE.
      g. Stem: Bronze.
      h. Stem Extension: 1.25-inches
      i. Ball: Chrome-plated brass.
      j. Port: Full.

2.3 CHAINWHEELS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Babbitt Steam Specialty Co. (www.babbittsteam.com)
   b. Roto Hammer Industries. (www.rotohammerinc.com)
   c. Trumbull Industries. (www.trumbull.com)

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to handwheels.
PART 3 EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chains on operators for ball valves more than 144 inches above floor except in shop areas. Extend chains to 12 inches above ceiling plane / lighting plane.

F. Install valve tags. Comply with requirements in Division 22 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze ball valves, two-piece with full port and bronze or brass trim.
3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Bronze ball valves, two-piece with full port and bronze or brass trim.

B. Pipe NPS 2-1/2 and Larger:
   1. Steel Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Steel ball valves, Class 150 with full port.

END OF SECTION
SECTION 220523
BUTTERFLY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Iron, single-flange butterfly valves.
      2. Iron, grooved-end butterfly valves.
      3. Chainwheels.

1.3 DEFINITIONS
   A. CWP: Cold working pressure.
   B. EPDM: Ethylene propylene-diene terpolymer rubber.
   C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of valve.
      1. Certification that products comply with NSF 61 Annex G.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Prepare valves for shipping as follows:
      1. Protect internal parts against rust and corrosion.
      2. Protect threads, flange faces, grooves, and weld ends.
      3. Set butterfly valves closed or slightly open.
   B. Use the following precautions during storage:
      1. Maintain valve end protection.
      2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
   C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand-wheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES
   A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

   B. ASME Compliance:
      1. ASME B16.1 for flanges on iron valves.
      2. ASME B16.5 for flanges on steel valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.9 for building service piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
F. Valve Sizes: Same as upstream piping unless otherwise indicated.
G. Valve Actuator Types:
   1. Gear Actuator: For valves NPS 8 and larger.
   3. Chainwheel: Device for attachment to gear, handlever, or stem; of size and with chain for mounting height, according to "Valve Installation" Article.
H. Valves in Insulated Piping: With 2-inch stem extensions.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES
A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABZ Valve and Controls (www.f-e-t.com)
      b. Apollo Valves; Conbraco Industries, Inc. (www.apollovalves.com)
      c. Cooper Cameron Valves (www.c-a-m.com)
      d. DeZurik (www.dezurik.com)
      e. Flo Fab, Inc. (www.flofab.com)
      f. FNW; Ferguson Enterprises, Inc. (www.fnw.com)
      g. Hammond Valve (www.hammondvalve.com)
      h. Jenkins Valves; Crane Energy Flow Solutions. (www.cranecpe.com)
      i. KITZ Corporation (www.kitz.com)
      j. Legend Valve & Fitting, Inc. (www.legendvalve.com)
      k. Milwaukee Valve Company (www.milwaukeevalve.com)
      l. NIBCO, Inc. (www.nibco.com)
      m. Norriseal (www.norrisale.com)
      n. Red-white Valve Corporation (www.redwhitevalvecorp.com)
      o. Spence Strainers International (www.ssiequipment.com)
      p. Stockman; Crane Energy Flow Solutions (www.cranecpe.com)
      q. Watts; a Watts Water Technologies Company (www.watts.com)
   2. Description:
      a. Standard: MSS SP-67, Type I.
      b. CWP Rating: 200 psig.
      c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      e. Seat: EPDM.
      f. Stem: One- or two-piece stainless steel.
      g. Disc: Aluminum bronze.

2.3 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES
A. Ductile Iron, Grooved-End Butterfly Valves, 175 CWP:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Kennedy Valve Company; a division of McWane, Inc. (www.kennedyvalve.com)
   b. Shurjoint Piping Products (www.shurjoint.com)
   c. Tyco Fire Products LP (tyco-fire.com)
   d. Victaulic Company, (www.victaulic.com)
   e. Zurn Industries, LLC (www.zurn.com)

2. Description:
   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 175 psig.
   c. Body Material: Coated, ductile iron.
   e. Disc: Coated, ductile iron.
   f. Seal: EPDM.

2.4 CHAINWHEELS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Babbitt Steam Specialty Co. (www.babbittsteam.com)
   b. Roto Hammer Industries. (www.rotohammerinc.com)
   c. Trumbull Industries. (www.trumbull.com)

   A. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to handwheels.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 144 inches above floor except in shop areas. Extend chains to 12 inches above ceiling plane / lighting plane.

F. Install valve tags. Comply with requirements in Division 22 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
   2. Ductile-Iron, Grooved-End Butterfly Valves: 175 CWP.

END OF SECTION
SECTION 220523
CHECK VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Bronze swing check valves.
      2. Iron swing check valves.

1.3 DEFINITIONS
   A. CWP: Cold working pressure.
   B. EPDM: Ethylene propylene-diene terpolymer rubber.
   C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of valve.
      1. Certification that products comply with NSF 61 Annex G.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Prepare valves for shipping as follows:
      1. Protect internal parts against rust and corrosion.
      2. Protect threads, flange faces, grooves, and weld ends.
      3. Set check valves in either closed or open position.
   B. Use the following precautions during storage:
      1. Maintain valve end protection.
      2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
   C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES
   A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
   B. ASME Compliance:
      1. ASME B1.20.1 for threads for threaded end valves.
      2. ASME B16.1 for flanges on iron valves.
      3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.


E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves and Bronze Disc, Class 125:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Valve, Inc. (www.americanvalve.com)
      b. Apollo Valves; Conbraco Industries, Inc. (www.apollovalve.com)
      c. Crane; Crane Energy Flow Solutions (www.cranecpe.com)
      d. Hammond Valve. (www.hammondvalve.com)
      e. Kitz Corporation. (www.kitz.com)
      f. Milwaukee Valve Company. (www.milwaukeevalve.com)
      g. NIBCO Incorporated. (www.nibco.com)
      h. Powell Valves. (www.powellvalves.com)
      i. Red-White Valve Corporation. (www.redwhitevalvecorp.com)
      j. Stockham; Crane Energy Flow Solutions (www.cranecpe.com)
      k. Watts; a Watts Water Technology Company (www.watts.com)

   2. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 200 psig.
      c. Body Design: Horizontal flow.
      e. Ends: Threaded or soldered. See valve schedule articles.
      f. Disc: Bronze.

2.3 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 125:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; Conbraco Industries, Inc. (www.apollovalve.com)
      b. Crane; Crane Energy Flow Solutions (www.cranecpe.com)
      c. FNW; Ferguson Enterprises, Inc. (www.fnw.com)
      d. Hammond Valve. (www.hammondvalve.com)
      e. Jenkins Valves; Crane Energy Flow Solutions (www.cranecpe.com)
      f. Kitz Corporation. (www.kitz.com)
      g. Legend Valve & Fitting, Inc. (www.legendvalve.com)
      h. Macon Group (The) (www.macongroup.com)
      i. Milwaukee Valve Company. (www.milwaukeevalve.com)
      j. NIBCO Incorporated. (www.nibco.com)
2. Description:
   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged or threaded. See valve schedule articles.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.

2.4 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Iron Swing Check Valves with Lever- and Spring-Closure Control, Class 125:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the fol-
      lowing:
      a. Crane; Crane Energy Flow Solutions (www.cranecpe.com)
      b. Hammond Valve. (www.hammondvalve.com)
      c. Jenkins Valves; Crane Energy Flow Solutions (www.cranecpe.com)
      d. Milwaukee Valve Company. (www.milwaukeevalve.com)
      e. NIBCO Incorporated. (www.nibco.com)
      f. Stockham; Crane Energy Flow Solutions (www.cranecpe.com)
      g. Watts; a Watts Water Technology Company (www.watts.com)
   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. CWP Rating: 200 psig.
      c. Body Design: Clear or full waterway.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
      e. Ends: Flanged or threaded. See valve schedule articles.
      f. Trim: Bronze.
      g. Gasket: Asbestos free.
      h. Closure Control: Factory-installed, exterior lever and spring.

2.5 IRON, GROOVED-END SWING CHECK VALVES

A. Iron, Grooved-End Swing Check Valves, 300CWP:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the fol-
      lowing:
      a. Anvil International (www anvilintl.com)
      b. Shurjoint Piping Products (www.shurjoint.com)
      c. Tyco Fire Products LP (tyco-fire.com)
      d. Victaulic Company (www.victaulic.com)
   2. Description:
      a. CWP Rating: 300 psig.
      c. Seal: EPDM.
      d. Disc: Spring-operated, ductile iron or stainless steel.
PART 3 EXECUTION

3.1 EXAMINATION
A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION
A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
F. Lift Check Valves: With stem upright and plumb. Install valve tags. Comply with requirements in Division 22 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING
A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS
A. If valve applications are not indicated, use the following:
   1. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
      b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or spring.
B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
C. End Connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.
   3. For Copper Tubing, NPS 5 and Larger: Flanged.
   4. For Steel Piping, NPS 2 and Smaller: Threaded.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded.
   6. For Steel Piping, NPS 5 and Larger: Flanged.
   7. For Grooved-End Piping: Grooved.
3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Bronze swing check valves, Class 125, bronze disc with soldered or threaded end connections.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron swing check valves, Class 125 metal seats with threaded or flanged end connections.

END OF SECTION
SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Fiberglass pipe hangers.
   4. Metal framing systems.
   5. Fiberglass strut systems.
   6. Thermal-hanger shield inserts.
   7. Fastener systems.
   8. Pipe stands.
   9. Pipe positioning systems.
  10. Equipment supports.

B. Related Sections:
   1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
   3. Section 220548 "Noise and Vibration Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS
A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer, if required by the local Authorities Having Jurisdiction. Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Fiberglass strut systems.
   4. Pipe stands.
   5. Equipment supports.
C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS
A. Welding certificates.

1.7 QUALITY ASSURANCE
A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS
A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
B. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2.2 TRAPEZE PIPE HANGERS
A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS
A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.
      c. Flex-Strut Inc.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut Corporation; Tyco International, Ltd.
      g. Wesanco, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
4. Channels: Continuous slotted steel channel within turned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Metallic Coating: Hot dipped galvanized

2.4 THERMAL-HANGER SHIELD INSERTS
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Carpenter & Paterson, Inc.
4. ERICO International Corporation.
6. PHS Industries, Inc.
7. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
8. Piping Technology & Products, Inc.
9. Rilco Manufacturing Co., Inc.
10. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS
A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE POSITIONING SYSTEMS
A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 EQUIPMENT SUPPORTS
A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer’s operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer’s written instructions.

F. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.


I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:
1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS
A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS
A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.
3.4 ADJUSTING
A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING
A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099600 "High-Performance Coatings."
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE
A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use carbon-steel pipe hangers and supports or metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
H. Use padded hangers for piping that is subject to scratching.
I. Use thermal-hanger shield inserts for insulated piping and tubing.
J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
   3. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
   4. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   5. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
   8. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   6. C-Clamps (MSS Type 23): For structural shapes.
   7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
   8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
   9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      a. Light (MSS Type 31): 750 lb.
      b. Medium (MSS Type 32): 1500 lb.
      c. Heavy (MSS Type 33): 3000 lb.
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Isolation of vibrations induced by Plumbing Systems from spaces for which Noise Criteria have been established in Division 1, including vibration isolators, equipment bases, and flexible connections.

1.2 SUMMARY

A. Mount rotating and reciprocating plumbing equipment and piping on vibration isolators as noted in the Contract Documents. Select, install and adjust isolators to prevent the transmission of objectionable vibration and noise to the building structure.

1.3 RELATED WORK

A. Perform vibration isolation work in this Contract, including work described in other Divisions, to meet the product and execution requirements of this Section. Related work includes:

1. Division 1 – General Requirements
2. Division 1 – General Acoustic Requirements
3. Division 3 – Concrete
4. Division 4 – Masonry
5. Division 5 – Metals
6. Division 14 – Conveying Equipment
7. Division 22 – Plumbing
8. Division 23 – Heating, Ventilating and Air Condition
9. Division 23 – Noise and Vibration Control for HVAC Systems
10. Division 26 – Electrical
11. Division 26 – Noise and Vibration Control for Electrical Systems

1.4 QUALITY ASSURANCE

A. Provide all vibration isolators and equipment bases for Division 22, 23 and 26 work from product line of a single manufacturer, unless otherwise accepted by the Acoustics Consultant.

B. Select isolators to provide uniform deflections within acceptable tolerances when supporting the equipment approved for this project. Coordinate as required with the equipment manufacturers to accomplish this.

C. Provide engineering, isolator selection, site supervision, and inspection by manufacturer’s personnel who shall perform these services directly. Alert the Engineer and Acoustics Consultant of isolator selections that may result in resonances with the equipment and structural systems they are intended to isolate. Replace isolators that upon installation are found to resonate with the supported equipment.

D. Provide complete isolation systems that include all elements recommended by the manufacturer for compliance with project requirements and applicable codes, ordinances, and regulations. Include all incidental products and materials required for a complete installation even if not explicitly described in the Construction Documents.
E. Installation & Verification:
   1. Install vibration isolation systems using skilled workers trained and licensed, as applicable, by the manufacturer for installations of the types used on this project.
   2. Upon completion of the Work, provide final inspection by the manufacturer's representative and submit to the Architect and Engineer a written report authored by the manufacturer's representative certifying the correctness of installation and compliance with the approved submittal data. Include tabulation of the static deflection expected under design and operating loads in comparison with the actual static deflection measured in the completed installations.

1.5 STANDARDS

1.6 ENGINEERING
A. The Construction Documents are indicative of isolation requirements. Provide complete engineering services for all components of isolation systems used in this project.

1.7 SUBMITTALS
A. Submit manufacturer's data, shop drawings, and product performance certifications in accordance with Division 1.
B. Manufacturer's Data: Submit technical product data confirming that products comply with specified requirements:
   1. Illustrations and descriptions of components including, but not limited to isolators, equipment bases, anchors, and accessories.
   2. Operation and maintenance instructions.
C. Shop Drawings
   1. Details of isolation systems, including plan and section drawings indicating isolator and flexible connection locations and types, isolator and connector schedules, details for resilient penetrations, and installation details.
   2. Isolator location drawings will be based on contractor's shop drawings rather than engineer's drawings whenever possible. If shop drawings are not used, the contractor will be required to make field-modifications, including but not limited to replacement and/or relocation of isolators, based on final field conditions at no cost to the owner.
   3. Indicate substrate construction required of other subcontractors.
   4. An initial submittal "For Type Only" is acceptable to confirm the scope of the isolators on the project if the necessary shop drawings by others (i.e. ductwork or equipment) are not yet available to provide final isolator sizing at the time of the initial submission. In this case a follow-up submittal will be required indicating precise isolator sizing and location as noted elsewhere in this section.
D. Samples: provide a sample of each type of isolator assembly used in the project. It is not necessary to submit samples of each spring capacity and pad hardness.
E. Supervision plan for manufacturer's representative in the field during installation of vibration isolation systems.
F. General Requirements for Vibration Isolation Mounts and Hangers: Provide catalog cut sheets, shop drawings, and other documents as necessary to describe the installation and its components. Include the following information:

1. Calculations:
   a. Submit manufacturer’s engineer’s calculations of loads, deflections, and natural frequencies for record only.

2. Color code legend for spring and elastomer capacities.

3. Certifications:
   a. Certify that elastomeric pads meet the requirements of AASHTO Highway Bridge Specification.

4. Springs Summary, for each spring-based isolator:
   a. Equipment name and number
   b. Operating Weight of Equipment
   c. Lowest reciprocating or rotating speed
   d. Isolator type
   e. Weight supported by isolator
   f. Scheduled deflection
   g. Proposed deflection under operating load
   h. Natural Frequency
   i. Spring free height
   j. Spring operating height
   k. Spring solid height at coil bind
   l. Spring diameter

5. Elastomeric Pads, for each elastomer-based isolator:
   a. Equipment name and number
   b. Operating Weight of Equipment
   c. Isolator type
   d. Weight supported by isolator
   e. Pad bearing area
   f. Pad free height
   g. Pad operating height
   h. Scheduled deflection
   i. Proposed deflection under operating load
   j. Percent deflection
   k. Natural Frequency
   l. Hardness and compliance with AASHTO Bridge Bearing Neoprene quality standard

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers listed below have demonstrated an ability to comply with specifications for vibration isolation products similar to those required for this project. However, specific products made by the listed manufacturers do not all comply with the requirements of this specification. Subject to the requirement for a single manufacturer and the restrictions regarding unacceptable types of isolators, the products of the following manufacturers are acceptable sources for this project:

1. Mason Industries, Inc. (Mason), Hauppauge, New York
2. Kinetics Noise Control (Kinetics), Dublin, Ohio
3. Vibration Mountings and Controls Group (VMC Group), Houston, Texas
4. CDM Novitec (CDM), Evanston, IL
5. E.A.R., Indianapolis (EAR), Indiana
6. Thybar Corporation (Thybar), Addison, IL
7. Carlisle Hardcast (Carlisle), Wylie, TX

2.2 SPRING REQUIREMENTS

A. Provide steel springs with static deflections equal to or greater than those shown on the schedule at the end of this section. Submittals based on rated deflections will be rejected.

B. Size springs to provide not less than 50 percent additional travel to solid, coil-bind condition beyond the deflection under operating load.

C. Size springs so that diameter is not less than 80 percent of the height of the spring at operating load.

D. Provide springs that do not permanently deflect after loading to a solid, coil-bind condition.

E. Do not weld springs to other components of the isolator assembly unless specifically noted in the Submittals and accepted by the Acoustics Consultant.

F. Color code springs to allow positive identification after installation. Match color coding to the color code legend provided with the submittals.

2.3 ELASTOMER REQUIREMENTS

A. Provide elastomeric elements with static deflections equal to or greater than those shown on the Construction Documents. Submittals based on rated deflections will be rejected.

B. Provide neoprene elements with a maximum hardness of 40 durometer, Shore A rating, where possible, but in no case exceeding 50 durometer. Where deflections called out in the construction documents exceed those required to achieve the specified natural frequencies, the greater deflection will govern.

C. Meet AASHTO Highway Bridge Specifications for all neoprene products installed in irretrievable locations and as required elsewhere in the Construction Documents.

2.4 CORROSION RESISTANCE

A. Treat isolators and associated hardware for resistance to corrosion to the following requirements:

B. Interior exposure:

1. Steel isolator components: PVC coating or phosphate treatment with finish coat of industrial grade enamel paint.
2. Structural steel bases and associated components: Cleaned of welding slag, primed with zinc chromate primer (steel) or metal etching primer (aluminum); industrial grade enamel finish coat.
3. Nuts, bolts, and other fasteners: zinc electroplate with etching primer and enamel paint finish coat.

C. Exterior exposure:

1. Steel components: PVC coating; or hot-dipped or electroplated zinc with neoprene or bitumastic finish coat.
2. Aluminum components: etched and painted with industrial grade enamel paint.
3. Nuts, bolts, and other fasteners: zinc electroplate with etching primer and enamel paint finish coat.
2.5 ACCEPTABLE PRODUCTS

A. Equipment Bases & Rails

1. Type B-1 Bases – Steel Bases
   a. Provide rigid steel frames that will not twist, deform, deflect, or crack in any manner that would affect the operation of the isolated equipment or the performance of the isolators. Size steel bases to support equipment housings, motors, and associated pipe and duct elbows, electrical control elements, and any other related components requiring resilient support because of its location on the equipment side of the flexible connections to distribution ductwork and piping. Supply steel frame under this specifications section.
   b. Provide bases with minimum depth of 6 inches. Increase depth as required to achieve required rigidity with a minimum depth of one tenth of the longest dimension of the base. Space isolators not more than ten times the steel depth apart. Provide a minimum of 2 inches clearance between floor or housekeeping pad and underside of steel base. Use height-saving brackets if required to maintain equipment clearances.
   c. Acceptable products:
      1) Mason WF
      2) Kinetics SFB or SBB
      3) VMC Group WFB

2. Type B-2 Bases – Steel Rails
   a. Provide structural steel sections sized to prevent deflection and distortion that would affect operation of equipment and performance of isolators. Include end-mounting brackets for attachment of isolators.
   b. Provide a minimum of 2 inches clearance between underside of rail and floor or housekeeping slab. Provide not less than 12 inches from underside of rails to roof deck.
   c. Acceptable products:
      1) Thybar TEMS 1, 2, or 3

3. Type B-3 Bases – Concrete Inertia Bases
   a. Provide inertia bases of normal weight concrete (150 pcf) and appropriate steel reinforcing within perimeter frames of steel channel, in a rigid assembly that will not twist, deform, deflect, or crack in any manner that would affect the operation of the isolated equipment or the performance of the isolators. Size inertia bases to support equipment housings, motors, and associated pipe and duct elbows, electrical control elements, and any other related components requiring resilient support because of its location on the equipment side of the flexible connections to distribution ductwork and piping. Supply steel frame under this specifications section. Provide concrete under this section or Division 3.
   b. Provide bases with minimum thickness of 6 inches. Increase thickness as required to achieve required mass according to the Isolation Schedule within this specification. Size perimeter steel depth to be not less than one twelfth of the longest dimension of the base. Space isolators not more than ten times the slab thickness apart. Provide a minimum of 2 inches clearance between floor or housekeeping pad and underside of slab. Use height-saving brackets if required to maintain equipment clearances.
   c. Acceptable products:
      1) Mason types K and BMK
      2) Kinetics Type CIB
      3) VMC Group CPF
B. Floor-Supported Mounts

1. Type M-1 Mounts – Neoprene Pads
   a. 3/4"-inch minimum thickness, waffled or ribbed neoprene.
   b. Where multiple layers are required to provide the specified deflections, interleave pads with 16 gauge steel shim plates. Size pads for deflection equal to 10 to 15 percent of unloaded height and provide pads of sufficient thickness to achieve the specified deflection. Provide load-distributing top plates if required for uniform loading.
   c. Acceptable products for individual pads:
      1) Mason W, SW, and Super W
      2) Kinetics RSP
      3) VMC Group NRC Pads
   d. Acceptable products for neoprene/steel composite pads:
      1) Mason WSW
      2) Kinetics RSP with steel shim
      3) VMC Group NRC Flex Plates

2. Type M-2 Mounts – Neoprene-in-Shear Mounts
   a. Provide double-deflection in-shear isolators with steel bottom plates with pre-drilled bolt holes for attachment to floor or base, a threaded steel insert at the top of the isolator for attaching the equipment, and friction surfaces at both top and bottom. Coat all metal surfaces with neoprene.
   b. Acceptable products:
      1) Mason ND
      2) Kinetics RD
      3) VMC Group RVD

3. Type M-3 Mounts – Open Springs
   a. Provide isolators of the general characteristics described in paragraph 2.2, above, that are freestanding and laterally stable with no housing and that are furnished with level-adjustment bolts for rigid connection to the isolated equipment. Provide with molded neoprene cup or 1/4 inch thick elastomeric friction pad between isolator baseplate and its support. Vary spring size as required for equal deflection under non-uniformly distributed equipment loads.
   b. Acceptable products:
      1) Mason SLF
      2) Kinetics FDS
      3) VMC Group AC

4. Type M-4 Mounts – Restrained Open Springs
   a. Provide built-in adjustable spring restraints for equipment with operating weight greater than weight upon installation to prevent equipment from deflecting (or rising) when the additional weight is applied (or removed in the future). Provide isolators as specified for Type M-4 but with restraint studs and adjustable nuts. Provide ½ inch minimum clearance around the restraint studs. Use bridge-bearing quality neoprene for elastomeric friction pads at chillers and cooling towers.
   b. Acceptable products:
      1) Mason SLR
      2) Kinetics FLS
      3) VMC Group M
      4) VMC Group M
C. Ceiling-Supported Hangers
1. Type H-1 Hangers – Not Used
2. Type H-2 Hangers – Neoprene-in-Shear Hangers
   a. Provide neoprene-in-shear element mounted in a rigid steel hanger box. Mold neoprene element with a rod isolation bushing that prevents rigid contact between hanger rod and housing from vertical through an angular deflection of not less than 30 degrees in any direction.
   b. For ductwork hung by straps, provide hangers with eyes on the top and bottom to allow for bolting to the straps.
   c. Acceptable products:
      1) Mason HD and WHD
      2) Kinetics RH
      3) VMC Group RH
3. Type H-3 Hangers – Open Spring with Elastomer
   a. Provide neoprene-in-shear element of 1¼-inch minimum thickness and a spring of the general characteristics specified in Paragraph 2.2, above. Seat spring in a molded neoprene cup with steel washer reinforcing. Mold neoprene element with a rod isolation bushing that prevents rigid contact between hanger rod and housing from vertical through an angular deflection of not less than 15 degrees in any direction. Do not directly stack the spring and neoprene isolator elements.
   b. For ductwork hung by straps, provide hangers with eyes on the top and bottom to allow for bolting to the straps.
   c. Acceptable products:
      1) Mason 30N
      2) Kinetics SRH
      3) VMC Group HSRA
4. Type H-4 Hangers – Pre-Compressed Open Spring with Elastomer
   a. Provide built-in adjustable spring restraints for equipment with operating weight greater than weight upon installation to prevent equipment from deflecting (or rising) when the additional weight is applied (or removed in the future). Provide isolators similar to Type H-3, but pre-compressed with restraint mechanisms that can be released to free the spring when subjected to its operational load. Provide an integral scale to indicate amount of deflection.
   b. For ductwork hung by straps, provide hangers with eyes on the top and bottom to allow for bolting to the straps.
   c. Acceptable products:
      1) Mason PC30N
      2) Kinetics SRH, with restraints
      3) VMC Group HRSRA

D. Wall-Supported Equipment Mounts
1. Type W-1 Mount – Captive Neoprene
   a. Maximum 50 durometer solid neoprene or neoprene housed in steel casing. Provide threaded insert to receive equipment mounting bolt.
   b. Acceptable products:
      1) Mason BR, RBA, or RCA
      2) Kinetics RQ
      3) VMC Group MB, RSM
E.  Pipe Riser Supports & Guides

1.  Type P-1 Support – Neoprene Pipe Support
   a.  All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.
   b.  Acceptable products:
       1)  Mason ADA
       2)  Kinetics KPA
       3)  VMC Group LD

2.  Type P-2 Support – Neoprene Pipe Guide
   a.  Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and re-insertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.
   b.  Acceptable products:
       1)  Mason VSG
       2)  Kinetics KPG
       3)  VMC Group AG

F.  Flexible Connections

1.  Type FC-1 Connector – Neoprene Twin-Sphere Piping Connectors
   a.  Provide flanged twin-sphere or threaded single-sphere isolators with Kevlar cord and peroxide-cured EPDM body with steel rings embedded in flanges to prevent pull-out. Connectors must accept elongation, compression, axial, and transverse motion. Select materials to suit system temperature, pressure, and fluid type. Do not use control rods or cables to limit extension of the isolator.
   b.  Acceptable products:
       1)  Twin-sphere connectors:
           (a)  Mason types SFDEJ, SFDCR
           (b)  Kinetics Type FTC
           (c)  VMC Group 2600
       2)  Single-sphere connectors (only acceptable for pipe sizes where twin-sphere connectors are not available, see Schedule):
           (a)  Mason types SFEJ, SFU
           (b)  Kinetics Type FC
           (c)  VMC Group 2800

2.  Type FC-2 Connector – Flexible Braided Stainless Steel Hose
   a.  Provide carbon steel flanges for pipes greater than 3 inches diameter. Male nipples are acceptable for pipe diameters smaller than 3 inches.
   b.  Acceptable products:
       1)  Mason FFL and MN
       2)  Kinetics Kinflex BFMC
       3)  VMC Group SS

3.  Type FC-4 Connector – Below-Grade Penetration Seals
   a.  Modular EPDM, nitrile, or silicone seal, as appropriate for specific field conditions, with accompanying sleeves, caps, and accessories. Provide fire- and high-temperature rated components where required by project conditions and applicable codes.
   b.  Acceptable products:
       1)  PSI-Thunderline, Link-Seal
G. Resilient Wrap for Small-Diameter Pipe

1. Type SD-1 Wrap – Closed Cell Rubber Foam
   a. Provide minimum 3/4-inch thick closed cell rubber or neoprene wrap in sheets to be cut to size, or in pre-molded form to slip over the pipe/conduit without gaps.
      1) Armacell Armafix or Armaflex
      2) K-Flex Isul-Lock DS
      3) Aeroflex Aerofix or Aerocell
   b. Where closed cell rubber foam insulation is provided for thermal purposes, this insulation may serve as SD-1 wrap without provision of additional wrap for acoustic purposes.

3.1 ISOLATION ACCESSORIES

A. Elastomeric Isolators for Mounting Bolts

1. Provide neoprene grommets, bushings, and washers for all bolts used to secure isolators to floors and housekeeping slabs and for all snubbers. Size bolt holes and washers to accommodate grommets, sleeves, and bushings and to preclude contact between rigid components that would cause bridging between isolated elements and the building structure. Baseplates for neoprene pads may be rigidly bolted to the floor or housekeeping slab if the bolts secure the baseplates only and do not continue through the neoprene to meet any other rigid material. Do not exceed 40 durometer, Shore A hardness.

2. Acceptable products:
   a. Mason HG, HLB and HLW
   b. E.A.R. Isodamp and C-1000
   c. VMC Group RB

B. Thrust Restraints & Sway Braces

1. Provide spring isolators with the same characteristics and deflection as the isolator springs. Preset thrust restraint isolators in the factory and fine tune in the field to allow for a maximum of 1/4-inch deflection between at-rest and maximum-thrust conditions. Furnish with appropriate brackets to attach to equipment and the structure. Install restraints on centerline of thrust and symmetrically on both sides of the equipment.

2. Acceptable products:
   a. Mason WB
   b. Kinetics HSR
      1) VMC Group TRK

PART 3 EXECUTION

3.2 GENERAL

A. Before commencing installation examine the substrate and surrounding conditions to ensure that there is nothing to prevent proper and timely execution of the installation. Beginning work specified in this Section indicates acceptance of the substrate and surrounding conditions.

1. Install isolation systems in strict compliance with manufacturer’s recommendations and engineering, and submittal data. Make no rigid connections to structure that would compromise the performance of the isolation systems.

2. Resiliently mount or hang plumbing equipment and piping on structural components indicated on the Drawings and as specified in this section.
3. For all isolated equipment, make connections of piping and conduit using flexible connections specified in this section. Make no connections to isolated equipment in a manner that would compromise the performance of the isolation systems. Refer to Section 260548 – Noise and Vibration Control for Electrical Systems for requirements related to isolation of electrical equipment and connections.

4. Establish isolator locations for ease of installation, adjustment, and inspection as well as specified performance.

5. Replace isolators found to resonate with building structure, at no additional cost to the Owner.

3.3 GENERAL REQUIREMENTS FOR MOUNTS AND HANGERS

A. Align mounts and hangers squarely above or below the equipment mounting holes to avoid introducing lateral loads and deflection.

B. Deflection requirements:
   1. Verify installed isolators have deflections equal to or greater than deflections specified on the submittals.
   2. Where multiple deflections apply to a single isolator (where a single isolator supports multiple isolated elements), the largest deflection governs.
   3. Vary the size and/or hardness of isolators as required to yield equal deflection for all isolators supporting a single piece of equipment or length of pipe. Consult manufacturer for direction when specified isolators do not yield required deflection and correct non-compliant isolators at no cost to the Owner.

C. Support equipment and piping independently. Do not hang from other isolated equipment, ductwork, piping, or conduit.

D. Maintain 2 inches of clearance between isolated elements and walls, ceilings, and other non-isolated building components.

E. Isolate drain piping attached to vibration isolated equipment from rigid components of the building.

F. Limit stops must be inactive and out of contact with the isolator during equipment operation.

G. Adjust leveling bolts and hanger rod lengths so that equipment is level and in alignment with connecting ductwork and piping.

H. Restrained isolators may be substituted for unrestrained isolators at installer’s option to simplify installation.

I. Isolate hanger rods passing through barrier ceilings with elastomeric sleeves or grommets or treat as resilient penetrations in accordance with the details and Section 079219 – Acoustical Sealants. Unless noted otherwise, locate equipment, piping, and ductwork below barrier ceilings.

3.4 EQUIPMENT MOUNTED ON FLOORS, HOUSEKEEPING PADS, AND STRUCTURAL ELEMENTS

A. For equipment with bases, locate isolators on the sides of the base that are parallel to the equipment shaft.

B. At housekeeping slabs and pedestals, position isolators with entire bearing plate on slab or pedestal. Do not cantilever baseplates beyond edges of slabs and pedestals. Coordinate isolator locations with housekeeping slabs so that outboard height-saving mounts do not contact the housekeeping slabs. Notify contractor of work by others requiring remediation for proper installation of isolators.
C. For floor-mounted equipment, provide a minimum of 2 inches operating clearance from the lowest point of the base to the floor or housekeeping slab. Verify that 2 inches of unobstructed clearance has been provided in the final installation under operating loads. Correct nonconforming conditions at no cost to the Owner. Provide height-saving brackets as required to maintain required equipment clearances.

D. For concrete inertia bases, set steel perimeter on bond breaker material, provide steel reinforcing in compliance with Manufacturer's recommendations, and pour normal weight concrete to the full depth of the perimeter steel. If no reinforcing is specified, provide ½-inch reinforcing bar at 6-inch centers each way, and weld reinforcing to the perimeter steel 1½ inches above the bottom of the steel. Provide required anchor bolts held in position by steel templates during the pour.

3.5 ISOLATION SCHEDULE – EQUIPMENT

A. Provide isolation mounts and hangers for Plumbing equipment as follows (see also notes after table). Static deflections indicated in the table below are minimum values.

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>On Grade Installation</th>
<th>Above Grade Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
<td>Isolator</td>
</tr>
<tr>
<td>Base-Mounted Pumps &amp; Compressors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5HP or greater</td>
<td>B-3</td>
<td>M-3</td>
</tr>
<tr>
<td>Less than 5HP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inline Pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5HP or greater</td>
<td>B-3</td>
<td>M-3</td>
</tr>
<tr>
<td>Less than 5HP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sump &amp; Ejector Pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5HP or greater</td>
<td>B-1</td>
<td>M-4</td>
</tr>
<tr>
<td>Less than 5HP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Heaters / Boilers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive devices connected to rotating equipment (Expansion Tanks, Heat Exchangers, Deaerators, etc.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Schedule Notes:
   a. The static deflection listed in the Schedule is a minimum acceptable value for installed deflection. Manufacturers may need to submit isolators with a higher "nominal" deflection in order to achieve the deflection listed above.
   b. For equipment specified with B-1 bases, it is acceptable to install the isolators directly under the equipment without the use of the base if the equipment is able to be supported by point loads. This must be confirmed by the equipment manufacturer.
   c. Where inertia bases (type B-3) are indicated, they will be sized as follows:

<table>
<thead>
<tr>
<th>Motor Size</th>
<th>Minimum Thickness of Inertia Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 to 20 horsepower</td>
<td>6 inches</td>
</tr>
<tr>
<td>25 to 50 horsepower</td>
<td>8 inches</td>
</tr>
<tr>
<td>60 to 100 horsepower</td>
<td>10 inches</td>
</tr>
<tr>
<td>Greater than 100 horsepower</td>
<td>12 inches</td>
</tr>
</tbody>
</table>

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d. Quick reference for isolator types:
   1) Base B-1: Steel frame
   2) Base B-2: Steel rails
   3) Base B-3: Concrete inertia base
   4) Mount M-1: Neoprene pad
   5) Mount M-2: Neoprene-in-shear
   6) Mount M-3: Open spring
   7) Mount M-4: Restrained open spring
   8) Mount M-5: Pneumatic isolator
   9) Hanger H-1: Not used
   10) Hanger H-2: Neoprene-in-shear
   11) Hanger H-3: Open spring
   e. Hanger H-4: Pre-compressed open spring

### 3.6 ISOLATION SCHEDULE – PIPING, AND CONDUIT

A. Provide isolation mounts and hangers for piping and conduit as follows:

<table>
<thead>
<tr>
<th>Device</th>
<th>Flr/Clg</th>
<th>Wall</th>
<th>Defl.</th>
<th>Flr/Clg</th>
<th>Wall</th>
<th>Defl.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping (except where noted in 1.1 below)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater than 1” diameter</td>
<td>M-3/ H-3</td>
<td>W-1</td>
<td>1.0”</td>
<td>M-2/ H-2</td>
<td>W-1</td>
<td>0.3”</td>
</tr>
<tr>
<td>1” diameter or less</td>
<td>SD-1</td>
<td>SD-1</td>
<td>n/a</td>
<td>SD-1</td>
<td>SD-1</td>
<td>n/a</td>
</tr>
<tr>
<td>In Vertical Shaft (&gt;1” dia.)</td>
<td>P-1/P-2</td>
<td>--</td>
<td>0.3”</td>
<td>P-1/P-2</td>
<td>--</td>
<td>0.3”</td>
</tr>
<tr>
<td>Pipe Supports at Pumps</td>
<td>M-3/ H-3</td>
<td>W-1</td>
<td>1.0”</td>
<td>M-2/ H-2</td>
<td>W-1</td>
<td>0.3”</td>
</tr>
<tr>
<td>Conduit (see section 260548)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Schedule Notes:
   a. The distance away from equipment (or crossing an AIJ/AIC) is measured along the run of the piping, or conduit.
   b. Multiple pipe/conduit may be installed on the same trapeze hanger, with isolators supporting the trapeze. In the case of such ganged installations, the highest-deflection isolator should be used for the trapeze isolators.
   c. Where wall support indicates an “H-#” type isolator, this requires that the pipe/conduit be hung of a bracket that is wall mounted, with isolators within the length of a threaded rod supporting it.
   d. Where piping is provided with jacketed fiberglass insulation wrap, this insulation can fulfill the requirements of SD-1 wrap without provision of additional wrap for acoustic purposes.
   e. All isolation for piping and conduit includes elements such as:
1) Pipe valves
2) Electrical pull boxes and junction boxes

f. Piping connected to fan coil units, fan-powered boxes, and reheat coils does not require isolation mounts for 30 ft beyond the equipment (see requirements for flexible connectors below).

g. Pipe supports do not require additional isolation if they are supported off the same isolated B-1 or B-3 base as the equipment to which they are connected.

2. Position isolators as high as possible in the hanger rod or strap assembly but not in direct contact with the building structure without manufacturer's written authorization. Provide 1 inch minimum clearance between isolator housing and structure above. Provide side clearance for hangers to allow full 360-degree rotation about the rod axis without contacting any object.

3. Drain pipes for air handling units shall be supported only from the isolated air handling unit frame. The condensate shall drip into a funnel that is supported from the floor or floor drain. A gap of at least 2 inches shall be maintained between the end of the air handling unit drain pipe and funnel or floor drain.

3.7 ISOLATION SCHEDULE – FLEXIBLE CONNECTIONS

A. Provide flexible connections for all piping and conduit:

<table>
<thead>
<tr>
<th>Device</th>
<th>Size</th>
<th>Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping Connected to Reciprocating Equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pumps (except as noted below), Condensing Units, Boilers, Air Handling Units</strong></td>
<td>&lt; 2” diameter</td>
<td>FC-1 (single-sphere)</td>
</tr>
<tr>
<td>2” to 14” diameter</td>
<td>FC-1 (twin-sphere)</td>
<td></td>
</tr>
<tr>
<td>&gt;14” diameter</td>
<td>FC-1 (single sphere)</td>
<td></td>
</tr>
<tr>
<td><strong>Fan Coil Units, Fan-Powered Boxes</strong></td>
<td>All</td>
<td>FC-2</td>
</tr>
<tr>
<td><strong>Air Compressor Pumps</strong></td>
<td>All</td>
<td>FC-2</td>
</tr>
<tr>
<td><strong>Sewage Ejector Pumps</strong></td>
<td>All</td>
<td>Flexible coupling per pump supplier</td>
</tr>
<tr>
<td>Piping Connected to Passive Equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Heat Exchangers, Expansion Tanks, Glycol Tanks, Deaerators, Reheat Coils</strong></td>
<td>&lt; 2” diameter</td>
<td>FC-1 (single sphere)</td>
</tr>
<tr>
<td>2” to 14” diameter</td>
<td>FC-1 (single sphere)</td>
<td></td>
</tr>
<tr>
<td>&gt;14” diameter</td>
<td>FC-1 (single sphere)</td>
<td></td>
</tr>
<tr>
<td><strong>Air Compressor Tank</strong></td>
<td>All</td>
<td>FC-2</td>
</tr>
<tr>
<td>Piping crossing an AJU or AIC below grade</td>
<td>All</td>
<td>FC-4</td>
</tr>
</tbody>
</table>

1. Schedule Notes
   a. FC-3 flexible duct connections are to be configured as follows:
      1) Crimp fabric into duct flanges and seal airtight.
      2) Provide minimum separation of 6 inches between duct and equipment.
      3) Provide 1½ inch minimum slack or as required to accommodate full range of equipment and duct movement when subjected to maximum operating and lateral loads simultaneously without becoming taut.
      4) Utilize thrust restraints as required to limit horizontal movement so that flexible connections do not become taut under any combination of operational loads.
5) Mount flexible duct connections as close to equipment housings as practical but in no case beyond the first duct hanger.

3.8 ISOLATION SCHEDULE – ACCESSORIES

A. Provide isolation accessories for all isolated plumbing equipment as follows:
   1. All bolted connections between equipment and non-isolated structure, or at other locations recommended by the isolation manufacturer, must be made using Elastomeric Isolators for Mounting Bolts.

3.9 TESTING, EVALUATION AND ACCEPTANCE PROCEDURES

A. Upon completion of the installation, the vibration isolation manufacturer will send a representative to the site to inspect and approve the installation. The manufacturer’s field report must certify that all of the isolators have been installed in accordance with the manufacturer’s instructions and will include the type and measured static deflection of all spring isolators.

B. If it is found that the construction fails the acoustic test measurements or performance requirements identified in the Contract Documents, make changes necessary to meet the requirements identified in the Contract Documents and be responsible for the costs associated with performing all additional acoustical tests to verify the acoustic performance of the construction. Costs for additional acoustical testing shall include consulting fees at per hour rates in effect at the time of testing along with related expenses including, but not limited to, travel expenses and test equipment use charges.

END OF SECTION
SECTION 22 05 49
NOISE CONTROL ACCESSORIES FOR PLUMBING SYSTEMS

PART 1 GENERAL

1.1 SCOPE
A. This section includes
   1. Lagging wrap

1.2 RELATED SECTIONS
A. Division 1 – General Acoustical Requirements
B. Division 7 – Sealants

1.3 REFERENCES
A. American Society for Testing and Materials:
   3. E413-87 – Classification for Rating Sound Insulation

1.4 QUALIFICATIONS
A. Installer: Company specializing in performing the work of this Section with minimum 3 years documented experience.

1.5 REGULATORY REQUIREMENTS
A. Piping accessory components and installation to conform to applicable building codes

1.6 PERFORMANCE REQUIREMENTS
A. Noise control accessories creating a barrier between noise producing elements and occupied building spaces to meet minimum performance as indicated in the Contract Documents, when tested in accordance with ASTM E90-97 for classification under ASTM E413-87.

1.7 SUBMITTALS
A. Submit manufacturer’s data, shop drawings, and product performance certifications in accordance with specified requirements.
B. Submit technical product data indicating acoustic performance as follows:
   1. Lagging Wrap
      a. Transmission Loss in octave bands from 125Hz to 4000Hz.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site under provisions of Division 1.
B. Store and protect products under provisions of Division 1.
PART 2 PRODUCTS

2.1 LAGGING WRAP

A. Wrap:
   1. Lagging wrap to be comprised of mass loaded vinyl of 1 psf surface weight with fiberglass mesh reinforcing.
      a. Minimum operating temperature range of -40 degrees Fahrenheit to 180 degrees Fahrenheit
      b. Resistant to water, oil, fungi, weak acids and alkalis.
      c. Minimum transmission loss values (dB):

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>STC</th>
</tr>
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<tbody>
<tr>
<td>125</td>
<td>15</td>
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<tr>
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<tr>
<td>4k</td>
<td>37</td>
</tr>
<tr>
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<td>26</td>
</tr>
</tbody>
</table>

2. Acceptable products include:
   a. KNM-100RB by Kinetics Noise Control
   b. UN-10R by Unger
   c. AudioSeal AB10R by Acoustical Solutions

B. Insulation
   1. Glass fiber, mineral fiber or polyurethane foam insulation with density of 1.5pcf to 3pcf (24 to 48 kg/m^3).
   2. Insulation type to meet required thermal and fire ratings as indicated in the drawings.
   3. Thickness of insulation varies depending on the size of the element being wrapped in lagging material, refer to Part 3 of this specification.

C. Joint tape:
   1. Tape as recommended by lagging wrap manufacturer to seal joints and edges as required.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

B. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

A. Lagging Wrap
   1. Follow all manufacturer’s instructions for material handling and installation.
   2. For piping with risk of condensation within the external insulation, spray-apply vapor absorber to the outside of the element before installing insulation or utilize polyethylene sheet as a vapor barrier.
   3. Insulation around the outside of the element.
      a. Use insulation of the following thickness where the following does not interfere with thermal or fire ratings:
         1) Use 1 inch thick insulation for piping of 3 inch and smaller diameter and ductwork of 144 square inches or less in free area.
         2) Use 2 inch insulation for larger piping and ductwork.
b. Use insulation compatible with required fire ratings and thermal insulation as defined in the drawings and elsewhere in the specifications, when this differs from the thickness described above.

4. Wrap each element individually and continuously on all sides with a minimum overlap of 2 inches at seams.
   a. Tape all seams airtight using tape recommended by the lagging manufacturer. Do not use duct tape for this purpose.
   b. If clearance above the element to the underside of the structural deck does not permit installation of the lagging between the element and the deck, request direction from the Acoustics Consultant.
   c. If the lagging material needs to be field-cut to fit, dress the edges of the material according to manufacturer’s instructions prior to installation.

5. Install a second layer of the lagging where indicated in the drawings. Stagger seams not less than 12 inches from those of the first layer and tape as described above.

6. All layers of lagging must extend for the full length of piping scheduled for lagging, including elbows, branches, and terminal devices such as roof drains. Tape and seal the ends of the installation to perimeter walls and slabs.

7. Cut in access flaps for valves, access panels, and other items requiring access. Tape edges of access flaps and indelibly label each flap for its purpose.

### 3.3 PERFORMANCE TESTING

A. Notify the Engineer when the installation is substantially complete so that performance testing may be scheduled in conjunction with final punch list review.

B. Performance testing to be performed by others.

**END OF SECTION**
SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Valve tags.
   5. Warning tags.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification material and device.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
D. Ceiling tag identification for review and confirmation with Architect and owner.
E. Valve numbering scheme.
F. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION
A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS
A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: Blue.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
   1. Review and confirm labels with owner prior to marking and installation.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions. Review and confirm warning signs and labels with owner prior to marking and installation.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Review and confirm pipe labels with owner prior to marking and installation.
   2. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   3. Lettering Size: At least 1-1/2 inches high.
2.4 VALVE TAGS
A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.
B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Review and confirm valve schedules with owner prior to marking and installation.
   2. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS
A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 EXECUTION
3.1 PREPARATION
A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION
A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION
A. Piping Color-Coding: Painting of piping is specified in Division 09 Section.
B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
C. Pipe Label Color Schedule:
   1. Low-Pressure, Compressed-Air Piping:
      a. Background Color: Blue.
   2. Domestic Water Piping:
      a. Background Color: Green.
   3. Sanitary Waste and Storm Drainage Piping:
      a. Background Color: Green.

3.4 VALVE-TAG INSTALLATION
A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      c. Compressed Air: 1-1/2 inches round.
   2. Valve-Tag Color:
      b. Hot Water: Green.
      c. Compressed Air: Blue.
   3. Letter Color:
      c. Compressed Air: White.

3.5 WARNING-TAG INSTALLATION
A. Write required message on, and attach warning tags to, equipment and other items where required.

3.6 CEILING-TAG INSTALLATION
A. For equipment and branch isolation valves located above suspended ceilings, label ceiling grid (not the tile) at key access points with a clear adhesive label with bold black lettering (font size 16) with equipment, etc., ID information.

END OF SECTION
SECTION 220719
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes insulating the following plumbing piping services:
   1. Domestic cold-water piping.
   2. Domestic hot-water piping.
   3. Domestic recirculating hot-water piping.
   4. Exterior compressed air piping.
   5. Sanitary waste piping exposed to freezing conditions.
   6. Storm-water piping exposed to freezing conditions.
   7. Roof drains and rainwater leaders.
   8. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.4 QUALITY ASSURANCE
A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1.5 DELIVERY, STORAGE, AND HANDLING
A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION
A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 “Hangers and Supports for Plumbing Piping and Equipment.”
B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING
A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000-Degree Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
   2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 MASS LOADED VINYL LAGGING
A. Composite limp vinyl sheet consisting of two layers of vinyl over a 1.4 psf barrier layer with a minimum STC rating of 28 and a 1" fiberglass batting decoupler layer.

B. Products
   1. Kinetics Noise Control KNM-100ALQ
   2. Acoustical Surfaces B-10 QFA-9
   3. Barymat BM-1C
   4. Engineer Approved Equal

C. Product Characteristics
   1. The barrier shall be constructed of a 0.12" thick mass loaded, limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side.
      a. Nominal density of barrier: 1.6 psf
b. Minimum STC rating: 30

c. Minimum Flammability rating per Federal Test Standard No. 191-5903:
   1) 0.0 seconds flame-out
   2) 0.2" char length

d. NFPA 90A Flame Spread / Smoke Developed characteristics:
   1) Flame Spread: 10
   2) Smoke Developed: 40

e. Minimum thermal conductivity barrier layer:
   1) K value of 0.29

f. Rated service temperature range
   1) –40 degrees F to 220 degrees F

2. Decoupler layer
   a. 1" fibrous glass batting
   b. Non-woven porous scrim-coated glass cloth
   c. Quilting
      1) 4" diamond stitch to encapsulate glass fibers

3. Seams
   a. 6" overlap tab for field joint sealing
      1) 54" nominal barrier width
      2) 48" nominal decoupler width

2.3 INSULATING CEMENTS

   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Thermokote V.

   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.4 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

D. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Corning Corporation; 739, Dow Silicone.
      d. Speedline Corporation; Polyc VP Adhesive.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

2.6 SEALANTS

A. Joint Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Eagle Bridges - Marathon Industries; 405.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      c. Proto Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by jacket material manufacturer.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Engineered Brass Company.
      b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
      c. McGuire Manufacturing.
      d. Plumberex.
      e. Truebro; a brand of IPS Corporation.
      f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
   2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Truebro; a brand of IPS Corporation.
      b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
   2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.
H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistant joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 “Penetration Firestopping.”

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. But each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word “union.” Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   2. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer’s recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 MASS LOADED VINYL LAGGING INSTALLATION
A. Cut sound control lagging material to length, wrapped around the outside of the pipe or duct to which the material is to be applied
B. Fasten with mechanical fasteners or bands
C. Tapes or adhesives for FSK jacketing shall be used in addition to the mechanical fasteners
D. Install per manufacturer design guidelines.

3.8 FIELD-APPLIED JACKET INSTALLATION
A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer’s recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.9 FINISHES
A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 “Exterior Painting” and Section 099123 “Interior Painting.”
B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
C. Do not field paint aluminum or stainless-steel jackets.

3.10 PIPING INSULATION SCHEDULE, GENERAL
A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor’s option.
B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE
A. Domestic Cold Water:
1. NPS 1-1/4 and Smaller: Insulation shall be the following:
a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.
2. NPS 1-1/2 and Larger: Insulation shall be the following:
a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:
1. NPS 1-1/2 and Smaller: Insulation shall be the following:
a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.
2. NPS 2 and Larger: Insulation shall be the following:
a. Mineral-Fiber Pipe Insulation, Type I: 1-1/2 inch thick.

C. Domestic Chilled Water (Potable):
1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

D. Storm-water and Overflow:
1. Insulate roof drain bodies, down comers from roof drain bodies, horizontal piping to the connection at main vertical piping, and 10 feet down the vertical piping from the connection with the following:
a. Mineral-Fiber Pipe Insulation, Type I: 2 inch thick
2. Insulate overflow drain bodies, down comers from overflow roof drain bodies and piping within 10 feet of the overflow roof drains and overflow discharge conductors with the following:
a. Mineral-Fiber Pipe Insulation, Type I: 2 inch thick
3. Any storm and overflow water piping located within the Theater or Dance Studio shall be lagged with mass loaded vinyl or enclosed in a sheet rock lagging enclosure and shall not require insulation.

E. Condensate and Equipment Drain Water below 60 Degrees F:
1. Extend insulation to the connection to main sanitary or storm water piping, and all piping within 10 feet of the drain (including sanitary or storm water main piping).
2. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.

F. Floor Drains and floor sink traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Degrees F:
1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.

G. Sump pump discharge: Insulate drain tile, elevator pit, and other clear water waste discharge piping from the pump to the point of connection to another drainage system, or until the pipe discharges to grade.
1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

H. Plumbing Piping Where Heat Tracing Is Installed:
1. All Pipe Sizes: Insulation shall be the following:
a. Cellular Glass: 2 inches thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Compressed Air Piping:
1. All Pipe Sizes: Insulation shall be the following:
a. Cellular Glass: 2 inches thick.
3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE
A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor’s option.
C. Piping, Exposed:
   1. Piping located within 8 feet of the floor; less than 200 degrees F: PVC: 30 mils thick.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE
A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor’s option.
C. Piping, Exposed:
   1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.016 inch

END OF SECTION
SECTION 221116
DOMESTIC WATER PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 ACTION SUBMITTALS
A. Product Data: For transition fittings and dielectric fittings.

1.3 INFORMATIONAL SUBMITTALS
A. System purging and disinfecting activities report.
B. Field quality-control reports.

PART 2 PRODUCTS

2.1 PIPING MATERIALS
A. Comply with requirements in “Piping Schedule” Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with “NSF-pw.”

2.2 COPPER TUBE AND FITTINGS
A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.
C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
F. Copper Unions:
   1. MSS SP-123.
   4. Solder-joint or threaded ends.

2.3 STAINLESS-STEEL PIPING
A. Potable-water piping and components shall comply with NSF 61.
B. Stainless-Steel Pipe: ASTM A 312/A 312M, Schedule 10
C. Stainless-Steel Pipe Fittings: ASTM A 815/A 815M.
D. Appurtenances for Grooved-End, Stainless-Steel Pipe:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International.
   b. Grinnell Mechanical Products; Tyco Fire Products LP.
   c. Shurjoint Piping Products.
   d. Victaulic Company.


3. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:
   a. AWWA C606 for stainless-steel-pipe dimensions.
   b. Stainless-steel housing sections.
   c. Stainless-steel bolts and nuts.
   d. EPDM-rubber gaskets suitable for hot and cold water.
   e. Minimum Pressure Rating:
      1) NPS 8 and Smaller: 600 psig.

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:
   1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
   2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.5 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Color: Black or natural.

2.6 TRANSITION FITTINGS

A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
   3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cascade Waterworks Manufacturing.
      b. Dresser, Inc.; Piping Specialties Products.
      c. Ford Meter Box Company, Inc. (The).
      d. JCM Industries.
      e. Romac Industries, Inc.
f. Smith-Blair, Inc.; a Sensus company.
g. Viking Johnson.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
   b. Central Plastics Company.
   c. Matco-Norca.
   d. Watts; a division of Watts Water Technologies, Inc.
   e. Wilkins; a Zurn company.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180 deg F.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

C. Dielectric-Flange Insulating Kits:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.
2. Non-conducting materials for field assembly of companion flanges.
4. Gasket: Neoprene or Phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.

D. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elster Perfection Corporation.
   b. Grinnell Mechanical Products; Tyco Fire Products LP.
   c. Matco-Norca.
   d. Precision Plumbing Products, Inc.
   e. Victaulic Company.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.

PART 3 EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 for excavating, trenching, and backfilling.
3.2 PIPING INSTALLATION
A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
C. Install a set of shutoff valves, hose-end drain valve, strainer, and test tee with valve on each plumbing riser and floor take-offs in accessible location.
D. Install shutoff valves on domestic water piping such that the entire restroom may be shut-off.
E. Install shutoff valve immediately upstream of each dielectric fitting.
F. Install domestic water piping level and plumb.
G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
K. Install piping to permit valve servicing.
L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
M. Install piping free of sags and bends.
N. Install fittings for changes in direction and branch connections.
O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
P. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."
Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION
A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA’s "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA’s "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Joint flanges with gasket and bolts according to ASME B31.9.

I. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.
B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   4. NPS 2-1/2: 108 inches with 1/2-inch rod.
   5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   7. NPS 6: 12 feet with 3/4-inch rod.
   8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

G. Install supports for vertical steel piping every 15 feet.

H. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   7. NPS 6: 12 feet with 3/4-inch rod.
   8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical stainless-steel piping every 15 feet.

J. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:
   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
   c. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:
   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
   f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING
A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Repeat procedures if biological examination shows contamination.
      e. Submit water samples in sterile bottles to authorities having jurisdiction.
B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE
A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
B. Flanges and unions may be used for aboveground piping joints NPS 4 and larger, unless otherwise indicated.
C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
D. Aboveground domestic water piping, NPS 3 and smaller, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L; cast-or wrought-copper solder-joint fittings; and soldered joints.

E. Aboveground domestic water piping, NPS 4 and larger, shall be the following:
   1. Stainless-steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.
   2. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper, solder-joint fittings; and brazed joints.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use full-port ball valves for piping NPS 3 and smaller. Use butterfly, with flanged ends for piping NPS 4 and larger.
   2. Throttling Duty: Use ball valves for piping NPS 3 and smaller. Use butterfly valves with flanged ends for piping NPS 4 and larger.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION
SECTION 221119
DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Vacuum breakers.
      2. Backflow preventers.
      4. Temperature-actuated, water mixing valves.
      5. Strainers.
      6. Outlet boxes.
      8. Hose bibbs.
      9. Wall hydrants.
     10. Wall Faucet.
     11. Drain valves.
     13. Air vents.
     15. Flexible connectors.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Shop Drawings: For domestic water piping specialties.
      1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES
   A. Potable-water piping and components shall comply with NSF 61.
2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
      b. Cash Acme; a division of Reliance Worldwide Corporation.
      c. Conbraco Industries, Inc.
      d. FEBCO; a division of Watts Water Technologies, Inc.
      e. Rain Bird Corporation.
      f. Toro Company (The); Irrigation Div.
      g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   5. Inlet and Outlet Connections: Threaded.
   6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Arrowhead Brass Products.
      b. Cash Acme; a division of Reliance Worldwide Corporation.
      c. Conbraco Industries, Inc.
      d. Legend Valve.
      e. MIFAB, Inc.
      f. Prier Products, Inc.
      g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      h. Woodford Manufacturing Company; a division of WCM Industries, Inc.
      i. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
      j. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
      b. Conbraco Industries, Inc.
      c. FEBCO; a division of Watts Water Technologies, Inc.
      d. Flomatic Corporation.
      e. Toro Company (The); Irrigation Div.
      f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Size: Refer to Drawings.
6. Design Flow Rate: Refer to Drawings.
7. Selected Unit Flow Range Limits: Refer to Drawings.
8. Pressure Loss at Design Flow Rate: Refer to Drawings.
9. Accessories:
   a. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. FEBCO; a division of Watts Water Technologies, Inc.
      b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   2. Standard: ASSE 1012.
   3. Operation: Continuous-pressure applications.
   4. Size: NPS ¾
   5. Body: Bronze.
   7. Finish: Chrome plated.

B. Reduced-Pressure-Principle Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. FEBCO; a division of Watts Water Technologies, Inc.
      b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   3. Operation: Continuous-pressure applications.
   4. Pressure Loss: 12 psig maximum, through middle third of flow range.
   5. Size: Refer to Drawings.
   6. Design Flow Rate: Refer to Drawings.
   7. Selected Unit Flow Range Limits: Refer to Drawings.
   8. Pressure Loss at Design Flow Rate: 5 psig for sizes NPS 2 and smaller; 8 psig for NPS 2-1/2 and larger.
   9. Body: Bronze for NPS 2 and smaller; stainless steel for NPS 2-1/2 and larger.
  10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
  11. Configuration: Designed for horizontal, straight-through flow.
  12. Accessories:
      a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
      b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

C. Beverage-Dispensing-Equipment Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.
      b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   3. Operation: Continuous-pressure applications.

D. Backflow-Preventer Test Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. FEBCO; a division of Watts Water Technologies, Inc.
   c. Flomatic Corporation.
   d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.5 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Flo Fab Inc.
   c. ITT Corporation; Bell & Gossett Div.
   d. NIBCO Inc.
   e. TAC.
   f. TACO Incorporated.
   g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Type: Ball valve with two readout ports and memory-setting indicator.


4. Size: Same as connected piping, but not larger than NPS 2.

5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Flo Fab Inc.
   c. ITT Corporation; Bell & Gossett Div.
   d. NIBCO Inc.
   e. TAC.
   f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.

3. Size: Same as connected piping, but not smaller than NPS 2-1/2.

C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Lawler Manufacturing Company, Inc.
   c. Leonard Valve Company.
   d. Powers; a division of Watts Water Technologies, Inc.
   e. Symmons Industries, Inc.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: Refer to Schedules.
9. Tempered-Water Design Flow Rate: Refer to Schedules.
10. Selected Valve Flow Rate at 45-psig Pressure Drop: Refer to Schedules.
11. Pressure Drop at Design Flow Rate: Refer to Schedules.
13. Piping Finish: Copper.

B. Individual-Fixture, Water Tempering Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme; a division of Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.
   c. Honeywell International Inc.
   d. Lawler Manufacturing Company, Inc.
   e. Leonard Valve Company.
   f. Powers; a division of Watts Water Technologies, Inc.
   g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: Refer to Schedules.
9. Tempered-Water Design Flow Rate: Refer to Schedules.

2.7 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron [with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and] for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.033 inch.
   b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.
   c. Strainers NPS 5 and Larger: 0.125 inch.

2.8 OUTLET BOXES

A. Icemaker Outlet Boxes:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
b. IPS Corporation.
c. LSP Products Group, Inc.
d. Oatey.
e. Plastic Oddities.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.9 HOSE BIBBS

A. Hose Bibbs:
   4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
   5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
   8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
   10. Finish for Finished Rooms: Chrome or nickel plated.
   11. Operation for Equipment Rooms: Wheel handle or operating key.
   14. Include operating key with each operating-key hose bibb.
   15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Non-freeze Wall Hydrants:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Prier Products, Inc.
      b. Mansfield
   4. Operation: Loose key.
   5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
   6. Inlet: NPS 3/4 or NPS 1.
   7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
   8. Box: Deep, flush mounted with cover.
   12. Operating Keys(s): Two with each wall hydrant.

2.11 WALL FAUCET

A. Surface Mounted Wall Faucet:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Chicago Faucet Company.
2. Standard: ASME A112.21.3M.
3. Type: Non-freeze, concealed-outlet ground hydrant with box.
4. Operation: Loose key.
5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
8. Drain: Designed with hole to drain into ground when shut off.
11. Operating Key(s): Two with each ground hydrant.

2.12 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
   2. Pressure Rating: 400-psig minimum CWP.
   4. Body: Copper alloy.
   5. Ball: Chrome-plated brass.
   8. Inlet: Threaded or solder joint.

B. Gate-Valve-Type, Hose-End Drain Valves:
   2. Pressure Rating: Class 125.
   5. Inlet: NPS 3/4 threaded or solder joint.
   6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:
   1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
   2. Pressure Rating: 200-psig minimum CWP or Class 125.
   5. Drain: NPS 1/8 side outlet with cap.

2.13 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMTROL, Inc.
      b. Josam Company.
      c. MIFAB, Inc.
      d. Precision Plumbing Products, Inc.
      e. Sioux Chief Manufacturing Company, Inc.
g. Tyler Pipe; Wade Div.
h. Watts Drainage Products.
i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.14 AIR VENTS
A. Welded-Construction Automatic Air Vents:
   2. Pressure Rating: 150-psig minimum pressure rating.
   3. Float: Replaceable, corrosion-resistant metal.

2.15 FLEXIBLE CONNECTORS
1. Manufacturers: Subject to compliance with requirements, provide products by one of the follow-
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Flex Pression, Ltd.
   4. Flex-Weld Incorporated.
   5. Hyspan Precision Products, Inc.
   7. Metraflex, Inc.
   8. Proco Products, Inc.
   9. TOZEN Corporation.
   10. Unaflex.
   11. Universal Metal Hose; a Hyspan company.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and
   ends brazed to inner tubing.
   2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel
   wire-braid covering and ends welded to inner tubing.
   2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 EXECUTION

3.1 INSTALLATION
A. Install backflow preventers in each water supply to mechanical equipment and systems and to
   other equipment and water systems that may be sources of contamination. Comply with authorities
   having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.

3. Do not install bypass piping around backflow preventers.

B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

C. Install water-control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install cabinet-type units recessed in or surface mounted on wall as specified.

F. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

G. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

H. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
   1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

I. Install water-hammer arresters in water piping according to PDI-WH 201.

J. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Pressure vacuum breakers.
   2. Intermediate atmospheric-vent backflow preventers.
   3. Reduced-pressure-principle backflow preventers.
   5. Dual-check-valve backflow preventers.
   7. Calibrated balancing valves.
   8. Primary, thermostatic, water mixing valves.
   11. Supply-type, trap-seal primer valves.
B. Before marking and installation, confirm labeling and identification with owner. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check, backflow-prevention assembly, and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION
SECTION 221123
DOMESTIC WATER PUMPS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. In-line, sealless centrifugal pumps
   B. Related Sections include the following:
      1. Division 22 Section "Domestic-Water Packaged Booster Pumps" for booster systems.

1.3 DEFINITIONS
   A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 SUBMITTALS
   A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.5 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Retain shipping flange protective covers and protective coatings during storage.
   B. Protect bearings and couplings against damage.
   C. Comply with pump manufacturer's written rigging instructions for handling.

1.7 COORDINATION
   A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS
   A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
      1. Bell & Gossett Domestic Pump; ITT Corporation. (www.bell-gossett.com)
B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

C. Pump Construction:
   1. Pump and Motor Assembly: Hermetically sealed replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
   2. Casing: Bronze, with threaded or companion-flange connections.
   4. Motor: Single speed, unless otherwise indicated.

D. Capacities and Characteristics: Refer to equipment schedules

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 "Common Motor Requirements for Plumbing Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 CONTROLS

A. Refer also to Div. 23 Section “Sequence of Operation for HVAC Controls” for intended operation and BAS interface requirements.

B. Thermostats: Electric; adjustable for control of hot-water circulation pump.
   1. Type: Water-immersion temperature sensor, for installation in piping.
   2. Range: 65 to 200 deg F.
   4. Operation of Pump: On or off.

2.4 ELECTRICAL CONNECTION

A. Refer also to Electrical Coordination schedule for electrical connection requirements. Electrical connection requirements include, but are not limited to, variable speed drives, disconnects, voltage, controls/switching.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.

C. Install horizontally mounted, in-line, separately coupled and close-coupled centrifugal pumps with shaft(s) horizontal.

D. Install thermostats in hot-water return piping.
3.3 CONNECTIONS
A. Comply with requirements for piping specified in Division 22 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to pumps to allow service and maintenance.
C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
   1. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Division 22 "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Division 22 "Domestic Water Piping Specialties."
   2. Install pressure gage and snubber at suction of each pump and pressure gage and snubber at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Division 22 "Meters and Gages for Plumbing Piping."
D. Connect thermostats, to pumps that they control.
E. Interlock pump with building automation system.

3.4 IDENTIFICATION
A. Comply with requirements for identification specified in Division 22 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.5 STARTUP SERVICE
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set thermostats for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:
   a. Verify bearing lubrication.
      b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
      c. Verify that pump is rotating in the correct direction.
6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.6 ADJUSTING
A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.
B. Adjust initial temperature set points.
C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION
SECTION 221316
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions
      and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Pipe, tube, and fittings.
      2. Specialty pipe fittings.
      3.

1.3 DEFINITIONS
   A. EPDM: Ethylene-propylene-diene terpolymer rubber.
   B. LLDPE: Linear, low-density polyethylene plastic.
   C. NBR: Acrylonitrile-butadiene rubber.
   D. PE: Polyethylene plastic.
   E. PVC: Polyvinyl chloride plastic.
   F. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum working
      pressure unless otherwise indicated:

1.5 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

1.6 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.7 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
   B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for
      plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent
      piping and "NSF-sewer" for plastic sewer piping.
PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS
A. Comply with requirements in “Piping Schedule” Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS
A. Pipe and Fittings: ASTM A 888 or CISPI 301.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AB&I Foundry
      b. Charlotte Pipe and Foundry
      c. Tyler Pipe; Soil Pipe Division

B. Heavy-Duty, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Clamp-All Corp.
      c. Dallas Specialty & Manufacturing Company
      d. MIFAB, Incorporated
      e. Mission Rubber Company; a division of MCP Industries, Incorporated
      f. Stant.
      g. Tyler Pipe.
   3. Description: 301 Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, Neoprene sleeve with integral, center pipe stop.
   4. Bands:
      a. NPS 4 inches and less: 4 bands, 80 inch pounds torque.
      b. NPS 5 to NPS 6: 6 bands, 80 inch pounds torque.
      c. NPS 8 and NPS 10: 6 bands, 80 inch pounds torque.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS
A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.

B. Steel Pipe Pressure Fittings:
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.5 PVC PIPE AND FITTINGS

A. Solid-Wall Sch 40 PVC Pipe: ASTM D 2665, drain, waste, and vent.
B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
C. Adhesive Primer: ASTM F 656.
   1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
D. Solvent Cement: ASTM D 2564.
   1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers"

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Shielded, Non-pressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
         1) Cascade Waterworks Manufacturing Company
         2) Mission Rubber Company; a division of MCP Industries, Incorporated
      c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   4. Pressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
         1) Cascade Waterworks Manufacturing Company
         2) Dresser, Incorporated
         3) EBAA Iron, Incorporated
         4) JCM Industries, Incorporated
         5) Romac Industries, Incorporated
         6) Smith-Blair, Incorporated; a Sensus company.
         7) The Ford Meter Box Company, Incorporated
         8) Viking Johnson.
c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: Manufacturer's standard.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:
1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Capitol Manufacturing Company.
      2) Central Plastics Company.
      3) Hart Industries International, Incorporated
      4) Jomar International Ltd.
      5) Matco-Norca, Incorporated
      6) McDonald, A. Y. Manufacturing Company
      7) Watts Regulator Company; a division of Watts Water Technologies, Incorporated
      8) Wilkins; a Zurn company.
   b. Description:
      1) Standard: ASSE 1079.
      2) Pressure Rating: 125 psig minimum at 180 deg F
      3) End Connections: Solder-joint copper alloy and threaded ferrous.
3. Dielectric Flanges:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Capitol Manufacturing Company.
      2) Central Plastics Company.
      3) Matco-Norca, Incorporated
      4) Watts Regulator Company; a division of Watts Water Technologies, Incorporated
      5) Wilkins; a Zurn company.
   b. Description:
      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 125 psig minimum at 180 deg F.
      4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 EARTH MOVING
A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION
A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
B. Sanitary sewer piping more than 5-feet outside the building is specified in Division 33 Section "Sanitary Sewerage."

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1/2 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install steel piping according to applicable plumbing code.

O. 

P. Install underground PVC piping according to ASTM D 2321.

3.3 PLUMBING SPECIALTIES

A. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Sanitary Waste Piping Specialties."

B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."

C. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
D. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

E. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

F. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

G. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION


B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

E. Plastic, Non-pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.5 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Shielded, non-pressure transition couplings.

B. Dielectric Fittings:
   1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
   2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
   3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
   4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:
   1. Install shutoff valve on each sewage pump discharge.
2. Install full-port ball valve for piping NPS 3 and smaller.
3. Install gate valve for piping NPS 4 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.
   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
   2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
   3. Install backwater valves in accessible locations.
   4. Comply with requirements for backwater valve specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.7 HANGER AND SUPPORT INSTALLATION
A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install fiberglass pipe hangers for horizontal piping in corrosive environments.
   3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
   5. Vertical Piping: MSS Type 8 or Type 42, clamps.
   6. Install individual, straight, horizontal piping runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls.
      Support pipe rolls on trapeze.
   8. Base of Vertical Piping: MSS Type 52, spring hangers.
B. Support horizontal piping and tubing within 18 inches of each fitting and coupling.
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
   5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
   6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
F. Install supports for vertical cast-iron soil piping every 15 feet.
G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.
I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 2: 84 inches with 3/8-inch rod.
   2. NPS 3: 96 inches with 1/2-inch rod.
   3. NPS 4: 108 inches with 1/2-inch rod.
   4. NPS 6: 10 feet with 5/8-inch rod.
J. Install supports for vertical stainless-steel piping every 10 feet.
K. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.
   4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
   5. NPS 6: 10 feet with 5/8-inch rod.
   6. NPS 8: 10 feet with 3/4-inch rod.
L. Install supports for vertical copper tubing every 10 feet.
M. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
N. Bracing: Horizontal cast-iron pipe and fittings NPS 5 and larger shall be braced to prevent horizontal movement. Bracing shall be located at each branch connection and each change of direction.

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
C. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
   5. Install horizontal backwater valves with cleanout cover flush with floor.
   6. Comply with requirements for backwater valves, cleanouts, and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
   7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
E. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.9 IDENTIFICATION
A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.10 FIELD QUALITY CONTROL
A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

3.11 CLEANING AND PROTECTION
A. Clean interior of piping. Remove dirt and debris as work progresses.
B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
C. Place plugs in ends of uncompleted piping at end of day and when work stops.
D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.12 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 1.5 and smaller shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; heavy duty hubless-piping couplings; and coupled joints.

C. Aboveground, soil and waste piping NPS 2 to NPS 10 shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; heavy duty hubless-piping couplings; and coupled joints.

D. Aboveground, vent piping NPS 1.5 and smaller shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; heavy duty hubless-piping couplings; and coupled joints.

E. Aboveground, vent piping NPS 2 to NPS 10 shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; heavy duty hubless-piping couplings; and coupled joints.

F. Underground, soil, waste, and vent piping NPS 12 and smaller shall be the following:
   1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

G. Underground, soil and waste piping NPS 15 and larger shall be the following:
   1. Solid wall PVC pipe; PVC socket fittings; and solvent-cemented joints.

END OF SECTION
SECTION 221319
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Cleanouts.
   2. Floor drains.
   3. Floor Sinks.
   4. Roof flashing assemblies.
   5. Through-penetration fire stops assemblies.
   7. Flashing materials.
B. Related Requirements:
   1. Division 22 Section "Storm Drainage Piping Specialties" for storm drainage piping inside the building, drainage piping specialties, and drains.
   2. Division 22 Section "Plumbing Fixtures" for hair interceptors.
   3. Division 33 Section "Storm Utility Drainage Piping" for storm draining piping and piping specialties outside the building.

1.3 DEFINITIONS
B. FRP: Fiberglass-reinforced plastic.
C. HDPE: High-density polyethylene plastic.
D. PE: Polyethylene plastic.
E. PP: Polypropylene plastic.
F. PVC: Polyvinyl chloride plastic.

1.4 PRODUCT ACTION SUBMITTALS
A. Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.
B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.
   f. Josam Company; Blucher-Josam Div.

2. Standard: ASME A112.36.2M for cast iron or ASME A112.3.1 for stainless steel for cleanout test tee.

3. Refer to cleanout schedule on drawings.

B. Metal Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Oatey.
   c. Sioux Chief Manufacturing Company, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Light Commercial Operation.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.
   i. Kusel Equipment Co.

2. Standard: ASME A112.36.2M

3. Refer to cleanout schedule on drawings.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
4. Refer to cleanout schedule on drawings.

2.2 FLOOR DRAINS
A. Cast-Iron Floor Drains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Zurn Plumbing Products Group
   2. Standard: ASME A112.6.3.
   3. Refer to floor drain schedule on drawings:

2.3 FLOOR SINKS
A. Cast-Iron Floor Sinks:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Zurn Plumbing Products Group
   2. Standard: ASME A112.6.3.
   3. Refer to floor drain schedule on drawings:

2.4 ROOF FLASHING ASSEMBLIES
A. Roof Flashing Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company; Elmdor/Stoneman Div.
      b. Thaler Metal Industries Ltd.
   B. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch-thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counter flashing fitting.
      1. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES
A. Through-Penetration Fire stop Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ProSet Systems Inc.
   2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
   3. Size: Same as connected soil, waste, or vent stack.
   4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
   6. Special Coating: Corrosion resistant on interior of fittings.
2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:
   1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
   2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:
   1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
   2. Size: Same as connected waste piping.
      a. NPS 2: 4-inch minimum water seal.
      b. NPS 2-1/2 and Larger: 5-inch minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:
   1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
   2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:
   1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
   2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:
   1. Description: Counter-flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
   2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:
   1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
   2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:
   1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper or galvanized steel.
   2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counter-flashing.

I. Expansion Joints:
   1. Standard: ASME A112.21.2M.
   2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.7 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
   2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Applications: 12 oz./sq. ft.
   2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.


E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains and floor sinks at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
   a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
   b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
   c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
G. Install through-penetration fire stop assemblies in plastic conductors and stacks at floor penetrations.
H. Assemble open drain fittings and install with top of hub 2 inches above floor.
I. Install deep-seal traps on floor drains and other waste outlets, if indicated.
J. Install floor-drain and floor sink, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.
K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
L. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
M. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
N. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
O. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
P. Install wood-blocking reinforcement for wall-mounting-type specialties.
Q. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS
   A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   B. Install piping adjacent to equipment to allow service and maintenance.
   C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
3.3 **FLASHING INSTALLATION**

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. **Lead Sheets:**  Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
2. **Copper Sheets:** Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. **Pipe Flashing:** Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. **Sleeve Flashing:** Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. **Embedded Specialty Flashing:** Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counter-flashings or commercially made flashing fittings, according to Division 07 Section “Sheet Metal Flashing and Trim.”

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 **PROTECTION**

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION
SECTION 221413
FACILITY STORM DRAINAGE PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions
      and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Pipe, tube, and fittings.
      2. Specialty pipe fittings.
   B. Related Sections:
      1. Section 221429 "Sump Pumps" for storm drainage pumps.

1.3 DEFINITIONS
   A. Hub Drain: Open ended drainage pipe. The hub end of a hub and spigot cast iron, or PVC pipe;
      open pipe end of a cast iron no-hub system. Hub drain material shall be the same as the connecting
      drainage system.

1.4 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum working pressure
      unless otherwise indicated:
      1. Storm Drainage Piping: 10-foot head of water.
      2. Storm Drainage, Force-Main Piping: 100 psig.
   B. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.6 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

2.1 PIPING MATERIALS
   A. Comply with requirements in “Piping Schedule” Article for applications of pipe, tube, fitting materials,
      and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS
   A. Pipe and Fittings: ASTM A 888 or CISPI 301.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. AB&I Foundry
b. Charlotte Pipe and Foundry
   c. Tyler Pipe; Soil Pipe Division

B. CISPI, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      c. Fernco Inc.
      d. Ideal
      e. Matco-Norca, Inc.
      f. MIFAB, Inc.
      g. Mission Rubber Company; a division of MCP Industries, Inc.
      h. Stant.
   3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Clamp-All Corp.
      d. Ideal
      e. MIFAB, Inc.
      f. Mission Rubber Company; a division of MCP Industries, Inc.
      g. Stant.
      h. Tyler Pipe.
   3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight. Include square-cut-grooved or threaded ends matching joining method.


C. Steel-Pipe Pressure Fittings:

D. Cast-Iron Flanges: ASME B16.1, Class 125.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International.
   b. Grinnell Mechanical Products.
   c. Shurjoint Piping Products.
   d. Victaulic Company.


3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:
   1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Grooved-Joint Piping:
   2. Ductile-Iron-Pipe Appurtenances:
   3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Anvil International.
      2) Shurjoint Piping Products.
      3) Star Pipe Products.
      4) Victaulic Company.

2.5 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.
   1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564.
   1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2.6 **SPECIALTY PIPE FITTINGS**

A. **Transition Couplings:**

1. **General Requirements:** Fitting or device for joining piping with small differences in OD’s or of different materials. Include end connections same size as and compatible with pipes to be joined.

2. **Fitting-Type Transition Couplings:** Manufactured piping coupling or specified-piping-system fitting.

3. **Unshielded, Non-pressure Transition Couplings:**

4. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   
   2) Fernco Inc.
   3) Mission Rubber Company; a division of MCP Industries, Inc.
   4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

   **b. Standard:** ASTM C 1173.

   **c. Description:** Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

   **d. Sleeve Materials:**
   2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

5. **Shielded, Non-pressure Transition Couplings:**

6. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

   2) Mission Rubber Company; a division of MCP Industries, Inc.

   **b. Standard:** ASTM C 1460.

   **c. Description:** Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

7. **Pressure Transition Couplings:**

8. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

   2) Dresser, Inc.
   3) EBAA Iron, Inc.
   4) Ford Meter Box Company, Inc. (The)
   5) JCM Industries, Inc.
   6) Romac Industries, Inc.
   7) Smith-Blair, Inc.; a Sensus company.
   8) Viking Johnson; c/o Mueller Co.

   **b. Standard:** AWWA C219.

   **c. Description:** Metal, sleeve-type couplings same size as, with pressure rating at least equal to and ends compatible with, pipes to be joined.

   **d. Center-Sleeve Material:** Carbon steel, Stainless steel and Ductile iron.

   **e. Gasket Material:** Natural or synthetic rubber.

   **Metal Component Finish:** Corrosion-resistant coating or material.
PART 3 EXECUTION

3.1 EARTH MOVING
   A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION
   A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.
   B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
   C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
   D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
   E. Install piping to permit valve servicing.
   F. Install piping at indicated slopes.
   G. Install piping free of sags and bends.
   H. Install fittings for changes in direction and branch connections.
   I. Install piping to allow application of insulation.
   J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
   K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
   L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
      1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.
      2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.
   M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   N. Install steel piping according to applicable plumbing code.
   O. Install aboveground PVC piping according to ASTM D 2665.
   P. Install underground PVC piping according to ASTM D 2321.
   Q. Plumbing Specialties:
      1. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."
2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."

3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

V. Cleanouts shall be submitted to architecture for review and confirmation of location before installation.

3.3 JOINT CONSTRUCTION


B. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

C. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

D. Plastic, Non-pressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Shielded, non-pressure transition couplings.
   4. In Underground Force-Main Piping:
      a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
      b. NPS 2 and Larger: Pressure transition couplings.
3.5 VALVE INSTALLATION
A. General valve installation requirements are specified in Section 220523 "General-Duty Valves for Plumbing Piping."
B. Shutoff Valves: Install shutoff valve on each sump pump discharge.
   1. Install gate or full-port ball valve for piping NPS 2 and smaller.
   2. Install gate valve for piping NPS 2-1/2 and larger.
C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION
A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   3. Vertical Piping: MSS Type 8 or Type 42, clamps.
   4. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer than 100 Feet: MSS Type 1, adjustable, steel clevis hangers.
      c. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
      d. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   6. Base of Vertical Piping: MSS Type 52, spring hangers.
B. Support horizontal piping and tubing within 18 inches of each fitting, valve, and coupling.
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
   5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
   6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
F. Install supports for vertical cast-iron soil piping every 15 feet.
G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
   8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.
H. Install supports for vertical steel piping every 15 feet.

I. Install supports for vertical copper tubing every 10 feet.

J. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
   2. NPS 3: 48 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
   5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

K. Install supports for vertical PVC piping every 48 inches.

L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.
   1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
   2. Install horizontal backwater valves with cleanout cover flush with floor.
   3. Comply with requirements for cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."
   4. Cleanouts shall be submitted to architecture for review and confirmation of location before installation.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:
   1. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
D. Test storm drainage piping according to procedures of authorities having jurisdiction and as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.10 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.
B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
   2. Galvanized-steel pipe, drainage fittings, and threaded joints.
C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
   2. Galvanized-steel pipe, drainage fittings, and threaded joints.
D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI, service weight, hubless-piping couplings; and coupled joints.
   2. Solid-wall Sch 40 PVC pipe, PVC socket fittings, and solvent-cemented joints.
E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI, service weight, hubless-piping couplings; and coupled joints.
   2. Solid-wall Sch 40 PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION
SECTION 221423
STORM DRAINAGE PIPING SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Roof drains.
   2. Miscellaneous storm drainage piping specialties.
   3. Cleanouts.
   4. Through-penetration firestop assemblies.
   5. Flashing materials.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE
A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

2.1 ROOF DRAINS
A. Cast-Iron, Large-Sump, General-Purpose Roof Drains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      c. Tyler Pipe.
      d. Watts Water Technologies, Inc.
      e. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.6.4, for general-purpose roof drains.
   5. Combination Flashing Ring and Gravel Stop: Required.
   6. Outlet: Bottom.
   7. Extension Collars: Required.
   8. Underdeck Clamp: Required.
   10. Sump Receiver Plate: Required.
   11. Dome Material: Aluminum or Cast iron.
   12. Perforated Gravel Guard: Stainless steel – required only if ballasted roof system used.
   14. Water Dam: 2 inches high – Required for Overflow Drain bodies (RD-B).
   15. Refer to roof drain schedule for additional characteristics.
2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Adaptors:
   1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
   2. Size: Inlet size to match parapet drain outlet.

B. Downspout Boots:
   1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
   2. Size: Inlet size to match downspout and NPS 4 outlet.

C. Conductor/Downspout Nozzles:
   1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
   2. Size: Same as connected piping.

D. Expansion Joints:
   1. Standard: ASME A112.21.2M.
   2. Body: Cast iron with bronze sleeve, packing, and gland.
   3. End Connections: Matching connected piping.
   4. Size: Same as connected piping.

2.3 CLEANOUTS

A. Floor Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      b. Oatey.
      c. Sioux Chief Manufacturing Company, Inc.
      e. Tyler Pipe.
      f. Watts Water Technologies, Inc.
      g. Zurn Plumbing Products Group; Light Commercial Products Operation.
      h. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
   3. Size: Same as connected branch.
   4. Type: Adjustable housing.
   5. Body or Ferrule Material: Cast iron.
   6. Clamping Device: Not required.
   7. Adjustable Housing Material: Cast iron with threads.
   8. Frame and Cover Shape: Round.
   10. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Test Tees:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      b. MIFAB, Inc.
      d. Tyler Pipe.
      e. Watts Water Technologies, Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
3. Size: Same as connected drainage piping.
4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure Plug: Countersunk, brass.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

C. Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   b. MIFAB, Inc.
   d. Tyler Pipe.
   e. Watts Water Technologies, Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES
A. Through-Penetration Firestop Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. ProSet Systems Inc.
2. Standard: ASTM E 814, for through-penetration firestop assemblies.
3. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assem-
   blies.
4. Size: Same as connected pipe.
5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange
   on one end for installation in cast-in-place concrete slabs.
6. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring
   at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

2.5 FLASHING MATERIALS
A. Copper Sheet: ASTM B 152/B 152M, 12 oz. /sq. ft.
B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch
   minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized
   finish for painting if indicated.
C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thick-
   ness.
D. Fasteners: Metal compatible with material and substrate being fastened.
E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units re-
   quired for installation; matching or compatible with material being installed.
PART 3 EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
   1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Install expansion joints, if indicated, in roof drain outlets.
   3. Position roof drains for easy access and maintenance.

B. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

C. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

D. Install downspout boots at grade with top 18 inches above grade. Secure to building wall.

E. Install conductor downspout nozzles at exposed bottom of conductors where they spill onto grade.

F. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
   1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
   3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate cleanouts at base of each vertical soil and waste stack.

G. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

H. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

I. Install test tees in vertical conductors and near floor.

J. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

K. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

L. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION
SECTION 221429
SUMP PUMPS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Submersible sump pumps.
   2. Sump-pump basins and basin covers.
B. Related Section:
   1. Division 22 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Wiring Diagrams: For power, signal, and control wiring.
C. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Retain shipping flange protective covers and protective coatings during storage.
B. Protect bearings and couplings against damage.
C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS
A. Submersible, Fixed-Position, Single-Seal Sump Pumps:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following but are not limited to, the following:
      a. Bell & Gossett Domestic Pump; ITT Corporation. (www.bell-gossett.com)
      b. Goulds Pumps; ITT Corporation. (www.gouldspumps.com)
      c. Grundfos Pumps Corp. (www.grundfos.com)
      d. Liberty Pumps. (www.libertypumps.com)
      e. Little Giant Pump Co. (www.little-giantpump.com)
f. Weil Pump Company, Inc. (www.weilpump.com)

2.** Description:**
   a. The duplex pump system eliminates unwanted water from elevator sumps, garages, vaults and other areas where preventing the unwanted discharge of oil to the environment is required.
   b. The pump controller shall include a pre-set level sensor which consists of 3 metal probes and a float switch which will control two sump pumps, one designated for water service, and one for oil service. When water collects in the sump and contacts both the lowest and the middle probe, the water service sump pump will discharge the water until the level is below the lowest probe. If the water level increases to the highest probe, the high water alarm sounds signifying a high inflow condition or faulty pump.
   c. In the event of an oil leak, the spilled oil will collect in the sump and float on the surface of the water. Once the layer is thick enough to trip the high oil float, the pump will eliminate the oil and water in the sump; the water will be pumped to the drain and then the oil will be routed to the waste oil storage tank preventing unwanted contamination.

3. **Pump Type:** Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.

4. **Pump Casing:** Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.

5. **Impeller:** Statically and dynamically balanced, ASTM A 532/A 532M, abrasion-resistant cast iron design for clear wastewater handling, and keyed and secured to shaft.

6. **Pump and Motor Shaft:** Stainless steel, with factory-sealed, grease-lubricated ball bearings.

7. **Seal:** The pump shall have a unitized carbon / ceramic seal with stainless steel housings and spring, or engineered double lip seal with stainless steel springs. The motor plate / housing interface shall be sealed with a Buna-N o-ring.

8. **Motor:** Hermetically sealed with a Buna-N o-ring, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
   a. Motor Housing Fluid: Oil filled.

9. **Controls:**
   a. The controls shall be housed in a NEMA 4X rated enclosure with a transparent hinged door. The door shall be closed with hasps which are capable of being padlocked. The enclosure shall have a painted steel dead front to protect the user from the panel wiring while also allowing access to the Touchscreen controls and power breakers.
   b. The primary means of operator interface shall be by way of a touchscreen interface. This interface shall provide graphic feedback of the system status as well as allow for selection of Auto/Manual control of the pump and valves. The controls shall include dry contact for the alarm status of the system.
   c. The controls shall have a method to electronically record the operation and status of the system while saving this record to a removable USB storage device. The data which has been logged shall be downloadable to via USB connection in a CSV format.
   d. The single phase control panel shall wired such that the pump and the controls are on two separate power circuits. These circuits shall each be protected by a circuit breaker, sized in accordance to the loading of the circuit. The three phase control panel shall utilize a single three phase power source. This circuit shall each be protected by a circuit breaker, sized in accordance to the loading of the circuit.
   e. The control unit has three probes and a float ball switch. The water pump will activate when the middle probe contacts water, and will remain on until the first, longest probe no longer is in contact with water. A high water alarm is activated when third or shortest probe contacts water.
f. When the oil layer present is thick enough to change the state of the float switch, and there is not water in the sump, the controller shall turn on the oil pump to evacuate the oil from the sump. When the oil layer present is thick enough to change the state of the float switch, and water is detected in the sump, the controller shall run the water pump to evacuate the water from the sump, and subsequently run the oil pump moving the oil to the holding tank for safe disposal.

Control-Interface Features:


4. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
   1) On-off status of pump.
   2) Alarm status.

10. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.

11. Guide-Rail Supports:
   b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
   c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
   d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
   e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
   f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
   g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

2.2 SUMP PUMP CAPACITIES AND CHARACTERISTICS

A. Refer to equipment schedules.

2.3 SUMP-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
   1. Material: Fiberglass or Polyethylene.
   2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
   3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate cast iron or ductile iron cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
   1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

2.4 BUILDING AUTOMATION SYSTEM INTERFACE

A. Refer also to Sequence of Operation for necessary control and interface requirements.

PART 3 EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Division 31 "Earth Moving."
3.2 EXAMINATION
A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION
A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.
B. Attach anchor flange to concrete slab to prevent the movement of the sump and basin. Provide any and all accessories, attachments, additional concrete and reinforcement as necessary.

3.4 CONNECTIONS
A. Comply with requirements for piping specified in Division 22 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.

3.5 FIELD QUALITY CONTROL
A. Tests and Inspections:
   1. Perform each visual and mechanical inspection.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
B. Pumps and controls will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

3.6 STARTUP SERVICE
A. Perform startup service. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING
A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
B. Adjust control set points.

3.8 DEMONSTRATION
A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION
SECTION 221513
GENERAL SERVICE COMPRESSED-AIR PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes piping and related specialties for general-service compressed-air systems operating at 150 psig or less.
B. Related Sections include the following:
   1. Division 22 Section "General-Service Packaged Air Compressors and Receivers" for general-service air compressors and accessories.

1.3 DEFINITIONS
A. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

1.4 SUBMITTALS
A. Product Data: For the following:
   1. Plastic pipes, fittings, and valves.
   2. Dielectric fittings.
   4. Pressure regulators.
   5. Automatic drain valves.
   6. Filters.
   7. Lubricators.
   8. Quick couplings.
   9. Hose assemblies.
B. Qualification Data: For Installers.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
C. ASME Compliance:
PART 2 PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L seamless, drawn-temper, water tube.
   1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
   2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
   3. Copper Unions: ASME B16.22 or MSS SP-123.
   4. Press-Type Fittings, NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Viega; Plumbing and Heating Systems.
   5. Press-Type Fittings, NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Viega; Plumbing and Heating Systems.

B. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 VALVES

A. Metal Ball, Butterfly, Check, Gate, and Globe Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping."

2.4 DIELECTRIC FITTINGS

A. General Requirements for Dielectric Fittings: Combination fitting of copper alloy and ferrous materials with insulating material; suitable for system fluid, pressure, and temperature. Include threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Dielectric Unions: Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Hart Industries International, Inc.
e. Watts Water Technologies, Inc.; Water Products Div.
f. Zurn Plumbing Products Group; Wilkins Div.

C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Central Plastics Company.
      c. EPCO Sales, Inc.

D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.

2.5 SPECIALTIES
A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, “Pressure Vessels,” construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.
   1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Line Pressure Regulators: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by:
      a. Norgren

2.6 QUICK COUPLINGS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aeroquip Corporation; Eaton Corp.
   2. Bowes Manufacturing Inc.
   3. Foster Manufacturing, Inc.
   5. Parker Hannifin Corp.; Fluid Connectors Group; Quick Coupling Div.
   6. Rectus Corp.
   7. Schrader-Bridgeport; Amflo Div.
   9. Snap-Tite, Inc.; Quick Disconnect & Valve Division.
10. TOMCO Products Inc.
11. Tuthill Corporation; Hansen Coupling Div.

B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
   1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
   2. Plug End: Flow-sensor-bleeder, check-valve or Straight-through type with barbed outlet for attaching hose.

D. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.
   1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
   2. Plug End: With barbed outlet for attaching hose.

2.7 HOSE ASSEMBLIES

A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig minimum working pressure, unless otherwise indicated.
   2. Hose Clamps: Stainless-steel clamps or bands.
   3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
   4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.
   5. Full Flow Stress Free Swivel
   6. Premium drive spring with declutching arbor and quiet latch cam.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:
   1. NPS 2 and Smaller: Type K or L, copper tube; wrought-copper fittings; and brazed joints.
   2. NPS 2 and Smaller: Type K or L, copper tube; press-type fittings; and pressure-sealed joints.

3.2 VALVE APPLICATIONS

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for metal general-duty valves. Use metal valves, unless otherwise indicated.
   1. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Division 22 Section "General-Duty Valves for Plumbing Piping" according to the following:
      a. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
      b. Equipment Isolation NPS 2 and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.
3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

E. Install piping adjacent to equipment and machines to allow service and maintenance.

F. Install air and drain piping with 1 percent slope downward in direction of flow.

G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.

H. Equipment and Specialty Flanged Connections:
   1. Use steel companion flange with gasket for connection to steel pipe.
   2. Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

I. Flanged joints may be used instead of specified joint for any piping or tubing system.

J. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, according to Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F 2014.

K. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

L. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

M. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."

N. Install piping to permit valve servicing.

O. Install piping free of sags and bends.

P. Install fittings for changes in direction and branch connections.

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints for Steel Piping: Join according to AWS D10.12/D10.12M.

E. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B 828 or CDA's "Copper Tube Handbook."

G. Extruded-Tee Outlets for Copper Tubing: Form branches according to ASTM F 2014, with tools recommended by procedure manufacturer, and using operators qualified according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

I. Pressure-Sealed Joints: Join with tools recommended by fitting manufacturer, using operators qualified according to Part 1 "Quality Assurance" Article.

J. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.5 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.

C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.

D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. NPS 2 and Smaller: Use dielectric unions.

3.7 FLEXIBLE PIPE CONNECTOR INSTALLATION

A. Install flexible pipe connectors in discharge of each air compressor.

B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.

3.8 SPECIALTY INSTALLATION

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-line pressure regulators in branch piping to equipment.

C. Install air-line lubricators in branch piping to machine tools.

D. Install quick couplings at piping terminals for hose connections.

E. Install hose assemblies at hose connections.
3.9 **CONNECTIONS**
A. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

3.10 **HANGER AND SUPPORT INSTALLATION**
A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
B. Vertical Piping: MSS Type 8 or 42, clamps.
C. Individual, Straight, Horizontal Piping Runs:
   1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.
   2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
E. Base of Vertical Piping: MSS Type 52, spring hangers.
F. Support horizontal piping within 12 inches of each fitting and coupling.
G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/4: 60 inches with 3/8-inch rod.
   2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
   4. NPS 1: 96 inches with 3/8-inch rod.
   6. NPS 1-1/2: 10 feet with 3/8-inch rod.
   7. NPS 2: 11 feet with 3/8-inch rod.
   8. NPS 2-1/2: 13 feet with 1/2-inch rod.
   9. NPS 3: 14 feet with 1/2-inch rod.
   10. NPS 3-1/2: 15 feet with 1/2-inch rod.
   11. NPS 4: 16 feet with 1/2-inch rod.
   12. NPS 5: 18 feet with 1/2-inch rod.
   14. NPS 8: 23 feet with 3/4-inch rod.
I. Install supports for vertical copper tubing every 10 feet.

3.11 **LABELING AND IDENTIFICATION**
A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.12 **FIELD QUALITY CONTROL**
A. Perform field tests and inspections.
B. Tests and Inspections:
1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect system for proper operation.

C. Prepare test reports.

END OF SECTION
SECTION 221519
GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Lubricated, reciprocating air compressors.
   2. Inlet-air filters.

1.3 DEFINITIONS
A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm.
B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
C. Standard Air: Free air at 68 deg F and 1 atmosphere (29.92 in. Hg) before compression or expansion and measured in scfm.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings:
   1. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For compressed-air equipment to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Air-Compressor, Inlet-Air-Filter Elements: Equal to 100 percent of amount installed, but no fewer than two units.
   2. Belts: Two for each belt-driven compressor.

1.7 FIELD CONDITIONS
A. Interruption of Existing Compressed-Air Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of compressed-air service.
2. Do not proceed with interruption of compressed-air service without Owner's written permission.

1.8 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

2.2 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS
A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.
B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
   1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
   3. Control Voltage: 120-V ac or less, using integral control power transformer.
   5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
   6. Instrumentation: Include discharge-air pressure gage, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gages, and control transformer.
   7. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.
C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   1. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
   2. Interior Finish: Corrosion-resistant coating.
   3. Accessories: Include safety valve, pressure gage, drain, and pressure-reducing valve.

2.3 LUBRICATED, RECIPROCATING AIR COMPRESSORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Atlas Copco (www.atlascopco.com)
   2. CompAir, Ltd. (www.compair.com)
   3. Curtis-Toledo. (us.fscurtis.com)
   5. General Air Products, Inc. (www.generalairproducts.com)
   6. Ingersoll-Rand (www.ingersollrandproducts.com)
   7. Kaeser Compressors, Inc. (www.kaeser.com)
   8. Powerex, Inc. (www.powerexinc.com)
9. Quincy Compressor (www.quincyccompressor.com)
10. Saylor-Beall Manufacturing Company (www.saylor-beall.com)

B. Provide duplex compressor unit consisting of oil-free air-cooled motor-compressor, air receiver, spring isolators, and operating controls.

C. Compressor(s): Lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.
   1. Submerged gear-type oil pump.
   2. Oil filter.
   3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
   4. Belt guard totally enclosing pulleys and belts.

D. Capacities and Characteristics: Refer to equipment schedules.

2.4 INLET-AIR FILTERS

A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.
   1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
   2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

B. Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.
   1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
   2. Capacity: Match total capacity of connected air compressors, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.5 COMPUTER INTERFACE CABINET

A. Description:
   1. Wall mounting.
   2. Welded steel with white enamel finish.
   3. Gasketed door.
   4. Grounding device.
   5. Factory-installed, signal circuit boards.
   7. Circuit breaker.
   8. Wiring terminal board.
   9. Internal wiring capable of interfacing 20 alarm signals.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 “Common Motor Requirements for Plumbing Equipment.”

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Equipment Mounting:
1. Install air compressors on cast-in-place concrete equipment base(s).
2. Comply with requirements for vibration isolation devices specified in Division 22 "Vibration Controls for Plumbing Piping and Equipment."

B. Install compressed-air equipment anchored to substrate.
C. Arrange equipment so controls and devices are accessible for servicing.
D. Maintain manufacturer's recommended clearances for service and maintenance.
E. Install the following devices on compressed-air equipment:
   1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
   2. Pressure Regulators: Install downstream from air compressors.

3.2 CONNECTIONS
A. Comply with requirements for piping specified in Division 22 "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to machine, allow space for service and maintenance.

3.3 IDENTIFICATION
A. Identify general-service air compressors and components. Comply with requirements for identification specified in Division 22 "Identification for Plumbing Piping and Equipment."

3.4 STARTUP SERVICE
A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check for lubricating oil in lubricated-type equipment.
   3. Check belt drives for proper tension.
   4. Verify that air-compressor inlet filters and piping are clear.
   5. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.
   6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure, but not higher than rating of system components.
   7. Drain receiver tanks.
   8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   9. Test and adjust controls and safeties.

3.5 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors.

END OF SECTION
SECTION 223400
FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS
A. Product Data: For each type and size of domestic-water heater indicated. [Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.]
B. LEED Submittals:
   1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, “Service Water Heating.”
C. Shop Drawings:
   1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of domestic-water heater, from manufacturer.
B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
C. Source quality-control reports.
D. Field quality-control reports.
E. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   A. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
   B. ASME Compliance:
1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.7 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including storage tank and supports.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.
   a. Commercial, Gas-Fired, Domestic-Water Heaters:
      1) Heat Exchanger: Five years.
      2) Controls and Other Components: Two years.
      3) Separate Hot-Water Storage Tanks: Five years.
   b. Compression Tanks: Five years.

PART 2 PRODUCTS

2.1 COMMERCIAL, FINNED-TUBE, GAS-FIRED, DOMESTIC-WATER HEATERS
A. Commercial, Gas-Fired, Domestic-Water Heaters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A.O. Smith Company (www.hotwater.com)
      b. Bradford White Corporation (www.bradfordwhite.com)
      c. CAMUS Hydronics Ltd. (www.camus-hydronics.com)
      d. HESco Industries, Inc. (hescoindustries.com)
      e. Laars Heating Systems Company (www.laars.com)
      f. Lochinvar, LLC (www.lochinvar.com)
      g. Raypak (www.raypak.com)
      h. RECO USA (www.recousaheaters.com)
      i. Rheem Manufacturing Company (www.rheem.com)
   3. Description: Packaged unit with boiler, storage tank, pump, piping, and controls.
      a. Heat Exchanger: Horizontal, straight, finned-copper tubes with bronze headers.
      b. Connections: Factory fabricated of materials compatible with boiler. Attach to boiler before testing.
         1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

5. Boiler Appurtenances:
   a. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire boiler except connections and controls.
   b. Jacket: Steel with enameled finish.
   c. Burner: For use with gas-fired, domestic-water heaters and natural gas fuel.
   e. Temperature Control: Adjustable, storage-tank temperature-control fitting and flow switch, interlocked with circulator and burner.
   f. Safety Control: Automatic, high-temperature-limit cutoff device or system.

6. Support: Steel base or skids.

7. Hot-Water Storage Tank: Connected with piping to circulating pump and domestic-water heater.
   b. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
      1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
      2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
   c. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

8. Factory-Installed Storage-Tank Appurtenances:
   b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005, factory installed.
   c. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
   d. Jacket: Steel with enameled finish.
   e. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

9. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig minimum working-pressure rating, and 225 deg F continuous-water-temperature rating.

10. Piping: Copper tubing; copper, solder-joint fittings; and brazed or flanged joints.

11. Mounting: Domestic-water heater, tank, and accessories factory mounted on skids.

B. Building Automation System Interface:
1. Provide domestic water heater with built in controls or all necessary accessories for building management system interface.
2. Control interface shall allow for enabling/disabling the water heater from building automation system, change temperature setpoints, and change temperature differentials.
3. Controller shall be able to perform the following:
   a. Configure protocols, network, characteristics, and client/server object definitions.
   b. Graphically interact with the internal database in real-time via USB connection
   c. Automatically discover and configure IP settings Ethernet gateways connected to the current subnet
4. Coordinate building automation system interface requirements including BACnet, wiring connections, and low-voltage power with building automation system provider.

C. Capacity and Characteristics:
1. Refer to equipment schedules for capacity and characteristics.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMTROL Inc. (www.amtrol.com)
      b. A.O. Smith Corporation (www.hotwater.com)
      c. Flexcon Industries (www.flexcondind.com)
      d. Honeywell International Inc. (Honeywell.com)
      e. Pentair Pump Group (www.pentair.com)
      f. State Industries (www.stateind.com)
      g. Taco, Inc. (www.taco-hvac.com)
   2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.
   3. Construction:
      a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
      b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      c. Air-Charging Valve: Factory installed.
   4. Capacity and Characteristics: Refer to equipment schedules for capacity and characteristics.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

D. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and calibrated balancing valves to provide balanced flow through each domestic-water heater.

E. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Division 22 "Ball Valves for Plumbing Piping," Division 22 "Butterfly Valves for Plumbing Piping," and Division 22 "Gate Valves for Plumbing Piping."
   1. Comply with requirements for balancing valves specified in Division 22 "Domestic Water Piping Specialties."


G. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include pressure rating as required to match gas supply.


I. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

J. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
K. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.
L. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.
M. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL
A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.
C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 "Quality Requirements" for retesting and re-inspecting requirements and Division 01 "Execution" for requirements for correcting the Work.
D. Prepare test and inspection reports.

PART 3 EXECUTION
3.1 DOMESTIC-WATER HEATER INSTALLATION
   1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
   2. Maintain manufacturer's recommended clearances.
   3. Arrange units so controls and devices that require servicing are accessible.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   7. Install anchor bolts to elevations required for proper attachment to supported equipment.
   8. Anchor domestic-water heaters to substrate.
B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
   1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 "Ball Valves for Plumbing Piping," Division 22 "Butterfly Valves for Plumbing Piping," and Division 22 "Gate Valves for Plumbing Piping."
C. Install gas-fired, domestic-water heaters according to NFPA 54.
   1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
   2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.

4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in other sections.

D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 "Domestic Water Piping Specialties."

F. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Division 22 "Meters and Gages for Plumbing Piping."

G. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Division 22 "Ball Valves for Plumbing Piping," Division 22 "Butterfly Valves for Plumbing Piping," and Division 22 "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Division 22 "Meters and Gages for Plumbing Piping."

H. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

I. Fill domestic-water heaters with water.

J. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Division 22 “Domestic Water Piping.”

B. Comply with requirements for fuel-oil piping specified in Division 22 "Facility Fuel-Oil Piping."

C. Comply with requirements for gas piping specified in other sections.

D. Drawings indicate general arrangement of piping, fittings, and specialties.

E. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

F. Building Automation System Interface: Factory or field install hardware and software to enable building automation system to monitor, control, and display domestic water heater status, alarms and setpoints.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 "Quality Requirements" for retesting and re-inspecting requirements and Division 01 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain domestic-water heaters and accessories.

END OF SECTION
SECTION 224000
PLUMBING FIXTURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following conventional plumbing fixtures and related components:
   1. Faucets.
   2. Flushometers.
   3. Toilet seats.
   4. Protective shielding guards.
   5. Fixture supports.
   7. Urinals.
   8. Lavatories.
  10. Service sinks.
  11. Service basins.

1.3 DEFINITIONS
B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
F. FRP: Fiberglass-reinforced plastic.
G. PMMA: Polymethyl methacrylate (acrylic) plastic.
H. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS
A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   3. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
   7. Vitreous-China Fixtures: ASME A112.19.2M.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
2. Brass and Copper Supplies: ASME A112.18.1.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Floor Drains: ASME A112.6.3.
4. Off-Floor Fixture Supports: ASME A112.6.1M.

1.6 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
5. Toilet Seats: Equal to 5 percent of amount of each type installed.
6. Dry Urinal Trap-Seal Cartridges: Equal to 200 percent of amount of each type installed, but no fewer than 12 of each type.
7. Dry Urinal Trap-Seal Liquid: Equal to 1 gal for each urinal installed.

PART 2 PRODUCTS

2.1 LAVATORY FAUCETS
A. Lavatory Faucets: Refer to plumbing fixture schedule
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Incorporated
   b. Chicago Faucets.
   c. Delta Faucets

2.2 SINK FAUCETS
A. Sink Faucets: Refer to plumbing fixture schedule.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Incorporated
   b. Chicago Faucets.
   c. Delta Faucets

2.3 FLUSHOMETERS
A. Flushometers: Refer to plumbing fixture schedule
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Incorporated
   b. Sloan

2.4 TOILET SEATS

A. Toilet Seats: Refer to plumbing fixture schedule
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Incorporated
      b. Bemis Manufacturing Company.
      c. Church Seats.
      d. Kohler Company
      e. Olsonite Corp.

2.5 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers: Refer to plumbing fixture schedule.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. McGuire Manufacturing Company, Incorporated
      b. Plumberex Specialty Products Incorporated
      c. TCI Products.
      d. TRUEBRO, Incorporated
   2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.6 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Josam Company.
   2. Smith, Jay R. Mfg. Company
   3. Tyler Pipe; Wade Division
   4. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Water-Closet Supports: Refer to plumbing fixture schedule
   1. Description: Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Urinal Supports: Refer to plumbing fixture schedule.
   1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture and type II, urinal carrier with hanger and bearing plates for wall-mounting, urinal-type fixture. Include steel uprights with feet.

D. Lavatory Supports: Refer to plumbing fixture schedule.
   1. Description: Type I, lavatory carrier with exposed arms and tie rods, type II, lavatory carrier with concealed arms and tie rod, and type III, lavatory carrier with hanger plate and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.

E. Sink Supports: Refer to plumbing fixture schedule.
   1. Description: Type I, sink carrier with exposed arms and tie rods, type II, sink carrier with hanger plate, bearing studs, and tie rod, and type III, sink carrier with hanger plate and exposed arms for sink-type fixture. Include steel uprights with feet.

2.7 WATER CLOSETS
A. Water Closets: Refer to plumbing fixture schedule
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Incorporated
      b. Sloan

2.8 URINALS
A. Urinals: Refer to plumbing fixture schedule.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Incorporated
      b. Sloan

2.9 LAVATORIES
A. Lavatories: Refer to plumbing fixture schedule.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Incorporated
      b. Kohler Company

2.10 COMMERCIAL SINKS
A. Commercial Sinks: Refer to plumbing fixture schedule.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Krauss Stainless Steel Sinks.
      b. Elkay Manufacturing Company
      c. Just Manufacturing Company.

2.11 SERVICE SINKS
A. Service Sinks: Refer to plumbing fixture schedule.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Incorporated
      b. Commercial Enameling Company.
      c. Eljer.
      d. Kohler Company

2.12 SERVICE BASINS
A. Service Basins: Refer to plumbing fixture schedule.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fiat Plumbing Fixtures
   b. Mustee Plumbing Fixtures
   c. Crane Plumbing, L.L.C./Fiat Products.

PART 3 EXECUTION

3.1 COORDINATION
   A. Coordinate plumbing fixture rough-in locations and plumbing fixture manufactures installation requirements.

3.2 EXAMINATION
   A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
   B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed before rough-in.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION
   A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers’ written instructions.
   B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
      1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
      2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
      3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
   C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
   D. Install wall-mounting fixtures with tubular waste piping attached to supports.
   E. Install counter-mounting fixtures in and attached to casework.
   F. Install fixtures level and plumb according to roughing-in drawings.
   G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
      1. Exception: Use ball valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
   H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
   I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
   J. Install accessible urinals with rim height not more than 17-inches or less than 16.5-inches above the finished floor.
   K. Install flush valves for accessible urinals with handle centered 44-inches above the finished floor.
L. Install flush valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install toilet seats on water closets.

N. Install trap-seal liquid in dry urinals.

O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

Q. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

R. Install shower flow-control fittings with specified maximum flow rates in shower arms.

S. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

T. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

V. Connect hard wired flushometer valves to electrical power source in accordance with manufacturer's written instructions and in compliance with the National Electrical Code.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.
3.6 ADJUSTING
A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
B. Operate and adjust disposers hot-water dispensers and controls. Replace damaged and malfunctioning units and controls.
C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
D. Replace washers and seals of leaking and dripping faucets and stops.

3.7 CLEANING
A. Clean fixtures, faucets, and other fittings with manufacturers’ recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.
B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.8 PROTECTION
A. Provide protective covering for installed fixtures and fittings.
B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION
SECTION 224500
EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes the following emergency plumbing fixtures:
   1. Combination units.
   2. Eyewash units

1.2 DEFINITIONS
A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.

D. Field quality control test reports.

E. Operation and Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals.

1.4 QUALITY ASSURANCE

B. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

A. Comply with the following applicable code standards:
   1. Accessible plumbing fixtures shall comply with all of the requirements of CBC Section 1115B.
   2. Heights and location of all fixtures shall be according to CBC Section 1115B.4 and DSA Check List Fig. 15-A.

1.5 WARRANTY
A. Special Warranties: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of plumbing fixtures that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures of unit shell.
      b. Faulty operation of controls and valves.
   2. Warranty Period for Commercial Applications: Three years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 COMBINATION UNITS

A. Wall-Mounted, Plumbed Emergency Shower with Eyewash Combination Units:
   1. Basis of design equipment
      a. Haws Corporation model 8355WCW.
   2. Construction: 18 Gauge Type 304 Stainless Steel recessed cabinet.
   3. Piping:
      a. Material: Chrome-plated brass or stainless steel.
      b. Unit Supply: NPS 1-1/4 minimum to unit.
      c. Unit Drain: Outlet at back or side near bottom.
   4. Shower:
      a. Capacity: Not less than 20 gpm for at least 15 minutes.
      b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
      c. Control-Valve Actuator: Pull bar.
      d. Shower Head: 8-inch minimum diameter, chrome-plated brass or stainless steel.
      e. 1" supply piping from from shower head to control valve shall be recessed in wall and provided by contractor.
      f. Mounting: Ceiling Hanger.
   5. Eyewash Unit:
      a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
      b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
      d. Spray-Head Assembly: Two receptor-mounted spray heads.
      e. Receptor: Chrome-plated brass or stainless steel bowl.
      f. Mounting: Wall mounting.

2.2 EYEWASH EQUIPMENT

A. Sink, Fixed-Position, Plumbed Eyewash Unit,
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following but are not limited to, the following:
   2. Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Acorn Safety; a division of Acorn Engineering Company.
      b. Bradley Corporation.
      c. Encon Safety Products.
      d. Guardian Equipment Co.
      e. Haws Corporation.
      f. Sellstrom Manufacturing Company.
      g. Speakman Company.
      h. WaterSaver Faucet Co.
   3. Capacity: Not less than 0.4 gpm for at least 15 minutes.
   4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   6. Spray-Head Assembly: Two spray heads positioned over sink.
   7. Mounting: Attached to sink receptor.

B. Sink, Swivel-Type, Plumbed Eyewash Unit,
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following but are not limited to, the following:
2. Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Acorn Safety; a division of Acorn Engineering Company.
   b. Bradley Corporation.
   c. Encon Safety Products.
   d. Guardian Equipment Co.
   e. Haws Corporation.
   f. Sellstrom Manufacturing Company.
   g. Speakman Company.
   h. WaterSaver Faucet Co.

3. Capacity: Not less than 0.4 gpm for at least 15 minutes.
4. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Movement of spray-head assembly to position over sink.
6. Spray-Head Assembly: Two spray heads with offset piping.
7. Mounting: Deck next to sink.

2.3 SOURCE QUALITY CONTROL
A. Certify performance of plumbed and self-contained emergency plumbing fixtures by independent testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION
A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
B. Install fixtures level and plumb.
C. Fasten fixtures to wall per manufacturer’s instructions.
D. Install shutoff valves in water-supply piping to fixtures. Use ball valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 22 Section “General Duty Valves for Plumbing Piping.”
   1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
E. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Division 22 “Meters and Gages for Plumbing Piping.”
F. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Division 22 “Sanitary Waste and Vent Piping.”
G. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Division 22 “Sanitary Waste and Vent Piping.”

H. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

I. Locate equipment at elevations to meet all ADA and accessibility requirements including wheel chair accessibility.

3.3 CONNECTIONS

A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Division 22 “Domestic Water Piping.”

B. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Division 22 "Sanitary Waste and Vent Piping."

C. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

D. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 FIELD QUALITY CONTROL

A. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

B. Report test results in writing.

3.5 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

END OF SECTION
SECTION 224716
PRESSURE WATER COOLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes pressure water coolers and related components.

1.2 SUBMITTALS
   A. Product Data: For each type of pressure water cooler.
      1. Include construction details, material descriptions, dimensions of individual components and
         profiles, and finishes.
      2. Include rated capacities, operating characteristics, electrical characteristics, and furnished spe-
         cialties and accessories.
   B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.3 EXTRA MATERIALS
   A. Furnish extra materials that match products installed and that are packaged with protective cover-
      ing for storage and identified with labels describing contents.
      1. Filter Cartridges: Equal to five percent of quantity installed for each type and size indicated, but
         no fewer than two of each.

PART 2 PRODUCTS

2.1 PRESSURE WATER COOLERS
   A. Pressure Water Coolers: Wall mounted, wheelchair accessible with bottle filler.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the fol-
         lowing:
         a. Elkay Manufacturing Company (www.elkay.com)

PART 3 EXECUTION

3.1 EXAMINATION
   A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify ac-
      tual locations of piping connections before fixture installation.
   B. Examine walls and floors for suitable conditions where fixtures will be installed.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION
A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
B. Set freestanding pressure water coolers on floor.
C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
D. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.
E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Install valves in locations where they can be easily reached for operation. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Division 22 “Escutcheons for Plumbing Piping.”
G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.
H. Coordinate electrical connections with electrical contractor. Ensure that electrical connections are completely concealed from view within water cooler enclosure.

3.3 CONNECTIONS
A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in Division 22 "Domestic Water Piping."
C. Install ball, gate, or globe shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Division 22 "General-Duty Valves for Plumbing Piping."
D. Comply with soil and waste piping requirements specified in Division 22 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING
A. Adjust fixture flow regulators for proper flow and stream height.
B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING
A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
B. Clean fixtures, on completion of installation, according to manufacturer’s written instructions.
C. Provide protective covering for installed fixtures.
D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION
SECTION 230500
COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. This project is seeking LEED Certification. All materials and installation practices must be in accordance with USGBC guidelines for a LEED Certified project.

1.2 SUMMARY
A. Design Development
   1. Documents: Design development specifications may include plumbing and HVAC equipment not required for this project. Equipment and capacities are identified on the drawings. Refer to the specifications for equipment characteristics, components, accessories, and installation requirements. These documents are not for construction.
   2. GMP pricing documents: This is a preliminary copy of the contract documents. The documents (drawings and project manual) are incomplete and issued to present the design intent. Equipment, material, and labor required to provide complete operating systems shall be included in the GMP.
   C. This Section includes the following:
      1. Piping materials and installation instructions common to most piping systems.
      2. Transition fittings.
      3. Dielectric fittings.
      5. Equipment installation requirements common to equipment sections.
      6. Painting and finishing.
      7. Concrete bases.
      8. Supports and anchorages.

1.3 BASIS-OF-DESIGN
A. Equipment manufacturers listed on the equipment schedules are the basis-of-design. Manufactures listed in the specification other than the basis-of design manufacture are acceptable substitutions. Equipment schedules are on the drawings. Refer to specifications for unscheduled equipment.

1.4 DEFINITIONS
A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PE: Polyethylene plastic.
   3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Escutcheons.

B. Welding certificates.

C. Coordination Drawings: Submit one copy for the engineers use. Division 23 coordination drawings will not be returned.
   1. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
      a. Planned piping layout, including valve and specialty locations and valve-stem movement.
      b. Planned piping hanger layout including building attachments and building structural coordination.
      c. Clearances for installing and maintaining insulation.
      d. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
      e. Equipment and accessory service connections and support details
      f. Exterior wall and foundation penetrations.
      g. Fire- and smoke-rated wall and floor penetration.
      h. Sizes and locations of required concrete equipment curbs and bases.
      i. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
      j. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
      k. Access door and panel locations.
      l. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

D. Equipment startup reports.
   1. Reports will indicate equipment was started and tested according to the manufactures recommendations and is operating as specified. Included test data.

E. Pre-demolition test reports.
1.6 QUALITY ASSURANCE
A. Comply with ASHRAE Guideline 4 – 2008 Preparation of operating and maintenance documentation for building systems.
B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
D. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.7 GUIDELINES, CODES AND STANDARDS
A. Refer to the most recently published edition for references to guidelines, and standards (examples: ASHRAE, NFPA, AWWA, ASTM) unless a specific edition is listed.
B. Installation and materials shall comply with applicable national, state, and local codes and ordinances.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
C. Deliver ducts and air handling equipment with factory or shop applied protective covering. Protective covering shall remain until installation.
D. Materials and equipment stored on site shall have a protective covering; open ends on equipment connections and ducts shall be covered. Duct liner shall be encapsulated.

1.9 COORDINATION
A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
D. Coordinate HVAC equipment installation with other building components.
E. Sequence, coordinate, and integrate installations of HVAC materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.
F. Coordinate connection of HVAC systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate connection of HVAC equipment and systems with building electrical systems.

1.10 GUIDELINES, CODES AND STANDARDS

A. Refer to the most recently published edition for references to guidelines, and standards (examples: ASHRAE, NFPA, AWWA, ASTM) unless a specific edition is listed.

B. Installation and materials shall comply with applicable national, state, and local codes and ordinances.

1.11 NOISE CRITICAL SPACES

A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). These spaces are the Theater, all spaces within the theater footprint (grids AF.3 to AC.2 and A1 to A6), Studios, Classrooms, Meeting Rooms, Green Room, and the Scene Shop.

B. Penetrations by ducts, pipes and conduit between noise critical spaces shall be sleeved, packed and sealed airtight with non-hardening sealant as described herein. Refer also to other requirements in plans and specifications. Where information is duplicated, in conflict, complementary, etc. the more stringent acoustic requirements shall apply.

PART 2 PRODUCTS

2.0 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F 493.
   2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 DIELECTRIC FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Pipeline Seal and Insulator, Incorporated (Pipeline Seal and Insulator, Incorporated)
   3. Watts Industries, Incorporated; Water Products Division (www.watts.com)

B. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 degrees F.

2.4 CONCRETE BASES

A. Refer to Division 03 Section "Cast-in-Place Concrete".

2.5 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HVAC DEMOLITION

A. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping to permit valve servicing.
G. Install piping at indicated slopes.
H. Install piping free of sags and bends.
I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Sleeves are not required for core-drilled holes through walls.
M. Verify final equipment locations for roughing-in.
N. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3.4 PIPING CONNECTIONS

A. Make connections according to the following unless otherwise indicated:
1. Install unions, in steel piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Wet Piping Systems: Install electric nipple fittings to connect piping materials of dissimilar metals.

B. Welded Joints: Construct joints according to AWS D1.12, using qualified processes and welding operators according to AWS D9.4/9.4M, Appendix. Plastic Piping: Select appropriate gasket material, size, type, and thickness for service application. Extend grease fittings to accessible locations.


D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated. To tube end, use lead-free solder alloy complying with ASTM B 32. Wet Piping Systems: Install electric nipple fittings to connect piping materials of dissimilar metals.

E. Threaded Joints: Thread pipe with tapered pipe thread according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix. PVC Pressure Piping: Join according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
3. PVC Non-pressure Piping: Join according to ASTM D 2855.
4. Use suitable lubricants on bolt threads.
F. Refer to equipment shop drawings for rough in locations; do not scale drawings.

3.6 PRODUCT INSTALLATION

A. Manufacturer’s instructions:
   1. Except where more stringent requirements are indicated, comply with the product manufacturer’s instructions and recommendations.
   2. Consult with manufacturer’s technical representatives, who are recognized as technical experts, for specific instructions on special projects conditions.
   3. If conflict exists, notify the Owner’s in writing and obtain his instruction before proceeding with the work in question.

B. Movement of Equipment:
   1. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed.
   2. Otherwise, advise Contractor of opening requirements to be maintained for the subsequent entry of equipment.

C. Heavy Equipment:
   1. Coordinate the movement of heavy items with shoring and bracing so that the building structure will not be overloaded during the movement and installation.
   2. Where plumbing products to be installed on the existing roof are too heavy to be hand-carried, do not transport across the existing roof deck. Position by crane or other device so as to avoid overloading or otherwise damaging the roof deck.

D. Clearances:
   1. Install Piping:
      a. Straight and true.
      b. Aligned with other work.
      c. Close to walls and overhead structure (allowing for insulation).
      d. Concealed, where possible, in occupied spaces.
      e. Out-of-the-way with maximum passageway and headroom remaining in each space.
   2. Do not obstruct windows, doors and other openings.
   3. Coordinate location of piping systems required to slope for drainage (over other service lines and ductwork).

E. Access:
   1. Provide for removal, without damage to other parts, of plumbing systems.
   2. Connect equipment for ease of disconnecting with minimum of interference with other work.
   3. Provide unions where required.
   4. Locate operating and control equipment and devices for easy access.
   5. Provide access panels where equipment or devices are concealed by non-accessible finishes and similar work.

3.7 CLOSING-IN OF UN-INSPECTED WORK

A. Do not allow or cause any work to be covered up or enclosed until inspected, tested and approved.

B. Should any work be enclosed or covered up before such inspection and test, Contractor shall, at his/her own expense, uncover work and after it has been inspected, tested and approved, make repairs with such materials as necessary to restore his/her work and that of other Divisions to original and proper condition.
3.8 PAINTING
A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.9 CONCRETE BASES
A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Provide 4-inch high curbs and bases with finished edges, unless otherwise indicated.
   3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   6. Install anchor bolts to elevations required for proper attachment to supported equipment.
   7. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   8. Use 3000-psi, 28-day compressive-strength concrete and reinforcement.
   9. Chamfer all outside corners of concrete bases and curbs.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES
A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
C. Field Welding: Comply with AWS D1.1.

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGES
A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
C. Attach to substrates as required to support applied loads.

3.12 GROUTING
A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
B. Clean surfaces that will come into contact with grout.
C. Provide forms as required for placement of grout.
D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout.

3.13 SEALANTS
A. Comply with joint-sealant materials and applications specified in Section 078400 “Firestopping,” Section 078443 “Fire-resistant Joint Sealants,” Section 079000 “Joint Protection,” and Section 092900 “Gypsum Board: Acoustical sealants.”

3.14 CYBERSECURITY RISK MITIGATION STRATEGY
A. Coordinate with Owner’s IT Department to restrict external network access to Internet connected system through virtual private network (VPN) connections only.
B. Security Event Log: Coordinate with the Owner to configure security event logging. Access to security logs shall be limited to users with proper authentication. Security logs shall be time stamped with Time and Date metadata for auditing and back-up.
C. Disable any protocols for remote connectivity, unless constantly required for day-to-day operations.
D. All external transport data shall be routed through encrypted channels with 2048-bit secure sockets layer (SSL).
E. Coordinate with Owner’s IT Department to implement a Web server-based human machine interface (HMI) that relies on IT technologies to secure access and restrict ports that can be opened on the firewall. Coordinate with Owner’s IT Department to restrict access to known IP addresses only.
F. Where building system networks are not physically separate from IT business networks, coordinate with Owner’s IT Department to segregate networked and Internet connected systems from the IT business network using virtual local area network (VLAN) IT technologies to restrict internal attacks/breakdowns.
G. Set unique, cryptographically strong passwords for administrator and user accounts. Default passwords must be changed before systems are connected to the Owner’s network.
H. Collect only the data that is necessary for analytics and optimization.
I. References:

3.15 RESPONSIBILITY MATRIX (RECOMMENDED)
A. The responsibility matrix is a partial list of items requiring coordination and is only a recommendation to the contractor. The contractor is responsible for the complete installation and operation of equipment and materials.
B. Refer to Division 22 Section “Common Work results for Plumbing” for additional requirements.
C. Key:
   1. BAS Building Automation System (Temperature Control Installer)
2. FP Fire Protection (Division 21)
3. PLBG Plumbing Installer (Division 22)
4. HVAC Mechanical Installer (Division 23)
5. E Electrical Installer (Division 26)
6. D Data/Communication Cabling Installer (Division 27)
7. O Other

<table>
<thead>
<tr>
<th>System Description</th>
<th>Furnished By</th>
<th>Installed By</th>
<th>Wired/Piped By</th>
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<td><strong>Hot Water Boilers</strong></td>
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<tr>
<td>Manufacture supplied field installed controls</td>
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<td>BAS</td>
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<td>CSD-1 Emergency shutdown</td>
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<td>Variable Frequency Drive: Power/Control</td>
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<td>System Description</td>
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<td>Wired/Piped By</td>
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**Fan Coil Air Terminal**

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<tr>
<td>Hot water heating coil control valve</td>
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<td>HVAC</td>
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<td>Fan current sensor</td>
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<td>Fan control relay</td>
<td>HVAC</td>
<td>HVAC</td>
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<td>Control transformer</td>
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<td>HVAC</td>
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**VAV Air Terminal**

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<tr>
<td>Hot water heating coil control valve</td>
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**Hot Water Unit Heaters**

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<td>Control valve</td>
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<td>Line voltage aquastat</td>
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**Radiation**

| Thermostat or temperature sensor                       | BAS          | BAS          | BAS            |
### System Description

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<th>Description</th>
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<th>Installed By</th>
<th>Wired/Piped By</th>
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<td>Control valve</td>
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<td><strong>Exhaust Fan</strong></td>
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<td></td>
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</tr>
<tr>
<td>Control relay/current sensor</td>
<td>BAS</td>
<td>BAS</td>
<td>BAS</td>
</tr>
<tr>
<td>Control damper(s)</td>
<td>BAS</td>
<td>HVAC</td>
<td>-</td>
</tr>
<tr>
<td>Control damper actuator(s)</td>
<td>BAS</td>
<td>BAS</td>
<td>BAS</td>
</tr>
<tr>
<td><strong>Power Roof Ventilators</strong></td>
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<tr>
<td>Control relay/current sensor</td>
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<td>BAS</td>
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<tr>
<td>Control damper(s)</td>
<td>HVAC</td>
<td>HVAC</td>
<td>-</td>
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<tr>
<td>Control damper actuator(s)</td>
<td>HVAC</td>
<td>HVAC</td>
<td>BAS</td>
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<tr>
<td><strong>Network</strong></td>
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<tr>
<td>LAN wiring to 1st tier supervisory TCP's</td>
<td>D</td>
<td>D</td>
<td>D</td>
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<tr>
<td>BAS 2nd tier (N2 Bus) communication wiring</td>
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<tr>
<td><strong>Control Power</strong></td>
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<td></td>
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</tr>
<tr>
<td>120v power to DDC panels</td>
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<td>E</td>
</tr>
<tr>
<td>120v power to VAV air terminal transformer panel</td>
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<td>E</td>
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<tr>
<td>120v circuit breaker to DDC Panel</td>
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<tr>
<td><strong>Control Wiring</strong></td>
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<tr>
<td>DDC panel input/output wiring</td>
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<td>BAS</td>
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<tr>
<td>DDC panel to motor starter/VFD</td>
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<td>BAS</td>
<td>BAS</td>
</tr>
<tr>
<td>24v power to dampers/valves</td>
<td>BAS</td>
<td>BAS</td>
<td>BAS</td>
</tr>
<tr>
<td>24v power to VAV air terminal</td>
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<tr>
<td><strong>Humidifier</strong></td>
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<td>Humidity sensor</td>
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<tr>
<td>Air flow proving switch</td>
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</tr>
<tr>
<td>Control valve</td>
<td>BAS</td>
<td>PLBG</td>
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<tr>
<td>Jacket valve</td>
<td>HVAC</td>
<td>HVAC</td>
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<tr>
<td><strong>Smoke Damper</strong></td>
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<tr>
<td>Smoke damper(s) &amp; actuator(s)</td>
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<td>HVAC</td>
<td>HVAC</td>
</tr>
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<td>120v power to smoke damper(s)</td>
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<td>E</td>
</tr>
<tr>
<td>Fire alarm system interlock signal (soft)</td>
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<td>-</td>
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<tr>
<td><strong>Fire Damper</strong></td>
<td></td>
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<tr>
<td>Fire damper(s)</td>
<td>HVAC</td>
<td>HVAC</td>
<td>-</td>
</tr>
<tr>
<td><strong>Combination Fire/Smoke Damper</strong></td>
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<td></td>
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<tr>
<td>Combination fire/smoke damper(s)</td>
<td>HVAC</td>
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### System Description

<table>
<thead>
<tr>
<th>Description</th>
<th>Furnished By</th>
<th>Installed By</th>
<th>Wired/Piped By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumatic actuator(s)</td>
<td>HVAC</td>
<td>HVAC</td>
<td>BAS</td>
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<tr>
<td>Electric actuator</td>
<td>HVAC</td>
<td>HVAC</td>
<td>E</td>
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<tr>
<td>120V to fire/smoke damper(s)</td>
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<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Fire alarm system interlock signal</td>
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</table>

**Emergency Generator**

<table>
<thead>
<tr>
<th>Description</th>
<th>Furnished By</th>
<th>Installed By</th>
<th>Wired/Piped By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package Diesel Engine Generator Set</td>
<td>E</td>
<td>E</td>
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<tr>
<td>120v power to day tank control panel</td>
<td>E</td>
<td>E</td>
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<tr>
<td>Day tank fuel level and transfer pump controls</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Fuel piping to day tank</td>
<td>HVAC</td>
<td>HVAC</td>
<td>HVAC</td>
</tr>
<tr>
<td>Fuel piping; day tank to engine</td>
<td>HVAC</td>
<td>HVAC</td>
<td>HVAC</td>
</tr>
<tr>
<td>Day tank vent piping</td>
<td>HVAC</td>
<td>HVAC</td>
<td>HVAC</td>
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<tr>
<td>Day tank emergency vent cap</td>
<td>E</td>
<td>HVAC</td>
<td>HVAC</td>
</tr>
<tr>
<td>Fuel solenoid valve(s)</td>
<td>E</td>
<td>HVAC</td>
<td>E</td>
</tr>
<tr>
<td>Fuel transfer pump</td>
<td>E</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>Fuel transfer pump piping</td>
<td>-</td>
<td>-</td>
<td>HVAC</td>
</tr>
<tr>
<td>Fuel transfer pump wiring (power &amp; control)</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Fuel leak detection system</td>
<td>HVAC</td>
<td>HVAC</td>
<td>BAS</td>
</tr>
<tr>
<td>120v power for fuel leak detection panel</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Ventilation Dampers</td>
<td>BAS</td>
<td>HVAC</td>
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<tr>
<td>Ventilation damper actuators</td>
<td>BAS</td>
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</tr>
<tr>
<td>Damper, generator, interlock</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
</tbody>
</table>

### 3.16 PRELIMINARY OPERATION

A. The Owner’s Representative reserves the right to operate portions of the mechanical system on a preliminary basis without voiding the guarantee or relieving the Contractor of his/her responsibilities.

### 3.17 OPERATIONAL TESTS

A. Before operational tests are performed, demonstrate to the Owner’s Representative that systems and components are complete and fully charged with operating fluid and lubricants. Systems shall be operable and capable of maintaining continuous uninterrupted operation during the operating and demonstration period.

B. After systems have been completely installed, connections made, and tests completed, operate the systems continuously for a period of five working days during the hours of a normal working day.

C. Rotating equipment shall be in dynamic balance and alignment.

D. Tests required in various sections herein shall be completed.

E. Notify the Owner’s Representative, in writing, two weeks in advance of this operational period.

F. This operational test may be concurrent with instruction of the Owner's operating personnel.
3.18 COMPLIANCE TESTS

A. Conduct tests for individual components of all portions of the installation as may be required by the various Sections of this Division to comply with the Contract Documents. Tests shall be made in the presence of the Owner’s Representative. Costs of tests shall be borne by the Contractor. Contractor shall provide all instruments, equipment, labor and materials to complete the tests. These tests may be required at any time between the installation of the work and the end of the warranty period. Should these tests expose any defective materials, poor workmanship or variance with requirements of Contract Documents, Contractor shall make any changes necessary and remedy any defects at no cost to the Owner.

END OF SECTION
SECTION 230502 - BASIC HVAC REQUIREMENTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Where contradictions occur between this Section and Division 01, and between contract specifications and drawings, the most stringent of the two shall apply. The Owner’s Representative shall decide which is most stringent.

B. All referenced and related provisions of Divisions 21, 22 and 26 shall also apply to the work of this Section as if fully repeated herein.

C. Provisions of this Section shall also apply to all Division 23 work.

D. Building systems commissioning: An independent third party Commissioning Agent will document completion of the Plumbing, HVAC, and Electrical Systems for the project. The Construction Manager and Division Contractors are members of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to other sections for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team.

1.2 DEFINITIONS

A. The definitions of Division 01 and the General Conditions of the Specifications also apply to the Division 23 contract.

B. “Contract Documents” constitute the drawings, specifications, general conditions, project manuals, etc., prepared by engineer (or other design professional in association with engineer) for contractor's bid or contractor's negotiations with the Owner. The Division 23 drawings and specifications prepared by the engineer are not Construction Documents.

C. “Construction Documents”, “construction drawings” and similar terms for Division 23 work refer to installation diagrams, shop drawings and coordination drawings prepared by the contractor using the design intent indicated on the Engineer’s Contract Documents. These specifications detail the contractor's responsibility for “Engineering by Contractor” and for preparation of construction documents.

D. “Furnish” means to “supply” and usually refers to an item of equipment.

E. “Install” means to “set in place, connect and place in full operational order”.

F. “Provide” means to “furnish and install”.

G. “Equal” or “Equivalent” means “meets the specifications of the referenced product or item in all significant aspects”. Significant aspects shall be as determined by the Owner’s Representative.

H. “Work by other(s) Divisions”, “re: Division” and similar expressions mean work to be performed under the contract documents, but not necessarily under the Division of Section of the work on which the note appears. It is the contractor’s sole responsibility to coordinate the work of the contract between his/her suppliers, subcontractors and employees. If clarification is required, consult Owner’s Representative before submitting bid.

I. By inference, any reference to a “contractor” or “sub-contractor” means the entity, which has contracted with the Owner for the work of the Contract Documents.

J. “Engineer” means the design professional firm, which has prepared these contract documents. All questions, submittals, etc. of this Division shall be routed to the Engineer (through proper contractual channels).
K. “Low Voltage Control Wiring” refers to all wiring systems which are 24 volts or less.
L. Exposed Locations: Locations in Mechanical Rooms or other areas exposed to view.
M. Concealed Locations: Locations in chases, shafts, furred spaces, attics, crawl spaces, above suspended ceilings, or other locations not exposed to view.

1.3 COORDINATION WITHIN DIVISION 23

A. Contract Documents:
1. General: The Contract Documents are diagrammatic showing certain physical relationships, which must be established within Division 23 work and its interface with other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing dimensions, clearances or material quantities.
2. Supplemental Instructions: The exact location for some items in this Specification may not be shown on the Drawings. The location of such items may be established by the Owner’s Representative during the progress of the work.
3. Discrepancies:
   a. Examine Drawings and Specifications of all Divisions of the work.
   b. Report any discrepancies to the Owner’s Representative and obtain written instructions before proceeding.
   c. Should there be a conflict within or between the Specifications or Drawings the most stringent or higher quality requirements shall apply.
   d. Items called for either in the Specifications or on the Drawings shall be required as if called for in both.
4. Constructability:
   a. Examine Drawings and Specifications of all Divisions of the work.
   b. Report any issues to the Owner’s Representative which may prevent installation of Division 23 work in accordance with the Contract Documents and the original construction contract.

B. Contractor shall be responsible for providing proper documentation of equipment product data and shop drawings to all entities providing service.

C. Coordination Drawings: Prepare coordination drawings in accordance with Division 01, Section “Submittals” to scale of 1/4” = 1'-0” or larger, detailing major elements, components, and systems of HVAC equipment (i.e. equipment rooms and exterior equipment areas) and materials in relationship with other systems, installations and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important to the efficient flow of the work, including (but not limited to) the following:
1. Indicate all ductwork, piping (HVAC, Plumbing and Fire Suppression), electrical equipment and conduits, structural and architectural elements in these areas as well.
2. Ductwork shop drawings shall include manual volume dampers, access doors, airflows (cfm’s), etc.
3. Sizes and locations of concrete pads, piers, curbs and bases.
4. Provide all necessary sections and elements for clarification.
5. Indicate all seismic restraint and support systems to be used for all HVAC equipment throughout the project.
6. Ductwork and piping transitions from rooftop units to shafts or horizontal ducts.
7. Failure to produce or submit coordination drawings does not dismiss the Contractor’s responsibility for translating the design intent of the Contract Documents into Construction Documents.
8. The coordination drawings shall include all trades with different colors representing different trades; and shall be signed off by all parties, but not limited to electrical, plumbing, fire protection, building automation and temperature control, and test and balance subcontractors, having work in the area. These drawings shall be submitted to the Owner’s Representative for review and approval.

D. Deferred Approval Items: Division 01.

E. Utility Connections:
   1. Coordinate the connection of HVAC system with utilities and services.
   2. Comply with regulations of utility suppliers.
   3. The contract documents indicate the available information on existing utilities and services, and on new services (if any) to be provided by utility companies and agencies.
      a. Notify the Owner’s Representative immediately if discrepancies are found.
   4. Coordinate HVAC utility interruptions one week in advance in writing with the Owner’s Representative and the Utility Company.
      a. Plan work so that duration of the interruption is kept to a minimum.

1.4 COORDINATION WITH OTHER DIVISIONS

A. General:
   1. Coordinate the Division 23 work with the progress of the work of the other trades.
   2. Complete the entire installation as soon as the condition of the building will permit.
   3. Contractor is responsible for coordination of their work with the Owner’s facility staff engaged in building automation, commissioning of systems, fire alarm system, etc.

B. Chases, Inserts and Openings:
   1. Provide measurements, drawings and layouts so that openings, inserts and chases in new construction can be built and coordinated as construction progresses.
   2. Check sizes and locations of openings provided.
   3. Any cutting and patching made necessary by failure to provide measurements, drawings and layouts at the proper time shall be done at no additional cost to the Owner.

C. Support Dimensions: Provide dimensions and drawings so that concrete bases and other equipment supports to be provided under other Sections of the Specifications can be built at the proper time.

D. Deferred Approved Items: Division 01.

1.5 ENGINEERING BY CONTRACTOR

A. The construction of this building requires the Contractor to design several systems of subsystems. All such designs shall be the complete responsibility of the Contractor.

B. Systems or subsystems which require responsibility by the Contractor and submitted to the Engineer for review include, but are not limited to:
   1. Equipment, ductwork and piping supports, not detailed in the drawings.
   2. Pipe and duct hangers and anchors not specified in these documents, or catalogued by the manufacturer.
   4. Thermal pipe stress analysis.

1.6 REGULATORY REQUIREMENTS

A. General:
1. Regulatory Compliance: Work performed under this Division shall comply with the latest currently adopted editions of Codes and Regulations including, but not limited to those listed below.

2. Minimum Requirements: The requirements of the Drawings and Specifications are the minimum that will be allowed, unless such requirements are exceeded by applicable Codes or Regulations, in which case the Code or Regulation requirement shall govern.

3. Code Changes: Should a code change occur between time of proposal and date of permit issue, and the Contractor has unnecessarily delayed the acquisition of permits, the Contractor shall hold the Owner free from additional expense resulting from such Code change.

B. Codes: Comply with the Currently Adopted (at Time of Contract Award) Codes

C. Comply with the Latest Editions of Applicable Regulations and Standards, Including:
   2. Underwriter’s Laboratories, Inc. (UL).
   5. American Society of Mechanical Engineers (ASME).
   10. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
   11. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

D. Requirements of Local Utility Companies: Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment, which will be required for the project.

E. Markings on Controllers: All mechanical equipment furnished with a controller/starter shall be marked with electrical data per NEC Section 430.8.

F. Additional Regulations: Follow additional regulations which appear in individual Sections of Specifications.

G. Contradictions: Where codes are contradictory, follow the most stringent, unless otherwise indicated in Plans or Specifications. The Owner’s Representative shall determine which is the most stringent.

H. Contract Documents Not in Compliance:
   1. Where it is not noted that the Drawings and Specifications do not comply with the minimum requirements of the codes, notify the Owner’s Representative in writing during the Bidding Period of the revisions required to meet Code Requirements. After entering into contract, Contractor will be held to complete all work necessary to meet Code Requirements without additional expense to the Owner.
   2. Follow Drawings and Specifications where they are superior to Code Requirements.

I. Permits:
   1. Contractor shall pay for and obtain all permits required by authorities and agencies having jurisdiction for the work in this Division.
   2. Post permits as required.

J. Inspections and Tests:
   1. Arrange for all required inspections and tests.
   2. Pay all charges.
   3. Notify the Owner’s Representative in writing 72 hours before tests.
4. Submit one copy for Owner’s record of permits. Licenses, inspection reports and test reports.

1.7 EQUIVALENTS AND SUBSTITUTIONS

A. The applicable paragraphs for General Requirements, Division 01 apply herein.

B. Basis of Design: The manufacturer’s name and product listed on the drawings, or listed first of several names in these Specifications, is used as a basis for design to establish space requirements, a standard of quality and performance.

C. Equivalents: Products of one or more other manufacturer’s names listed in these Specifications following the words “or equivalent by” may be selected, subject to paragraph below titled “Contractor’s Responsibility for Equivalent and Substitutions”.

D. Other Options:
   1. For products specified by naming only one manufacturer, refer to paragraph below under “Substitutions”.
   2. For products specified only by performance characteristics or reference standards, select any manufacturer meeting the requirements.

E. Substitutions: Requests for acceptance of a product of manufacturer’s name not listed in these Specifications will be considered if any one of the following conditions is met:
   1. The named product is not available because of strikes or discontinuance of manufacture; and the proposed product is equivalent to the named product.
   2. The proposed product is superior to the named product, in the opinion of the Owner’s Representative.
   3. The proposed product is equivalent to the named product and its use will be to the advantage of the Owner, by the Owner receiving an equitable credit or cost savings. The Owner’s Representative reserves the right to reject any substitution.
   4. Submit proposed substitutions with bid along with alternate price, complete descriptive data and a comparison of the substitute manufacturer’s product with specified product. Request for acceptance of a product of manufacturer’s name not listed in these Specifications, is subject to the paragraph titled “Contractor’s Responsibility Equivalents and Substitutions”.

F. Contractor’s Responsibility for Equivalents and Substitutions:
   1. Items submitted as a substitution to the Basis of Design or listed general equivalents shall be identified as such and shall include a written request for substitution indicating the following:
      b. Contract time adjustment.
      c. Item by item breakdown of differences between Basis of Design and substituted item.
      d. Operation, maintenance and energy cost difference.
   2. Products of manufacturer must match the features, construction, performance and size of those selected for design. Standard catalogued may require certain modifications to meet specified requirements.
   3. The responsibility for providing that specified requirements have been met remains with the manufacturer and Contractor. Should the substituted item fail to perform in accordance with the Specifications, replace same with the originally specified item without extra cost to the contract.
   4. When requesting review of an equivalent or substituted product, submit a comparison chart listing features, construction, performance and sizes of name product versus equivalent or substituted product.
   5. Submittals for review of an equivalent or substituted product will be reviewed for acceptability when all the above requirements have been met. Contractor shall be responsible for all costs incurred by the Architect and Engineer for review of equivalency beyond initial review.
   6. Coordinate the installation of the product with all trades.
7. Contractor shall be responsible for changes in electric wiring, materials and for all other additional costs of construction by all trades involved to accommodate the product to perform the same as the product used in the “Basis of Design”.
8. Coordination of General Equivalents and Substitutions: Where Contract Documents permits selection from general equivalents, or where substitutions are authorized, coordinate clearance and other interface requirements with HVAC and other work.
9. Provide necessary additional items so that selected or substituted item operates equivalent to the Basis of Design and properly fits in the available space allocated for the Basis of Design.
10. Contractor is responsible for assuring that piping, conduit, duct, flue and other service locations for general equivalents or substitutions do not cause access, service or operational difficulties any greater than would be encountered with the Basis of Design.
11. Failure to comply with these requirements will result in immediate rejection of the request for substitution.

1.8 GENERAL SUBMITTAL REQUIREMENTS

A. Refer to Division 01 for additional requirements.

B. Coordination and Sequencing:
   1. Coordinate submittals 3 weeks (minimum) prior to expected order date so that work will not be delayed by submittals.
   2. Do not submit product data, or allow its use on the project until compliance with requirement of Contract Documents has been confirmed by Contractor.
   3. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
   4. Submitting contractor is responsible for routing reviewed submittals to all parties affected including but not limited to electrical, building automation and temperature control, and test and balance subcontractors.
   5. Make submittals for group of similar products or materials such as valves, fixtures, pumps, air handling units, fans, insulation, etc. or area of work complete and at one time, not in piecemeal fashion.
   6. Identify submittals with Architect’s project name and number, with item designation as indicated on drawings, and referenced to applicable paragraphs of the specifications. Submit in brochure form.
   7. Submittals of products needed to start of Project for its installation, or those requiring a long lead time for assembly or manufacturing, should be submitted before the others.

C. Preparations of Submittals:
   1. Refer to Division 01 requirements.
   2. Provide permanent marking on each submittal to identify project, date, Contractor, Subcontractor, Supplier, submittal name and similar information to distinguish it from other submittals.
   3. Indicate any portions of work, which deviate from the Contract Documents.
      a. Explain the reasons for the deviations.
      b. Show how such deviations coordinate with interfacing portions of other work.
   4. Show Contractor’s executed review and approval marking.
   5. Provide space for the Owner’s Representative “Action” marking.
   6. Submittals, which are received from sources other than through Contractor’s office, will be returned “Without Action”.
   7. Submittals shall be presented in a neat and legible fashion and shall be returned “Without Action” if presented in any other fashion.

D. Response to Submittals: Where standard product data has been submitted, it is recognized:
   1. That the Submitter has determined that the products fulfill the specified requirements.
2. That the submittal is for the Owner’s Representative information only, but will be returned with appropriate action where observed to be not in compliance with the requirements.

E. If more than two submittals (either for shop drawings, or test and balance reports) are made by the Contractor due to the incompleteness, non-compliance, errors, omissions, etc. the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

1.9 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS

A. Manufacturer’s Data:
   1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black ink to indicate which of the variations is to be provided.
   2. Delete or mark-out significant portions of pre-printed data, which are not applicable.
   3. Where operating ranges are shown, mark data to show portion of range required for project application.
   4. For Each Product, Include the Following:
      a. Sizes.
      b. Weights.
      c. Speeds.
      d. Capacities.
      e. Piping and electrical connection sizes and locations.
      f. Statements of compliance with the required standards and regulations.
      g. Performance data.
      h. Manufacturer’s specifications and installation instructions.

B. Shop Drawings:
   1. Prepare HVAC shop drawings, except diagrams, to accurate scale.
      a. Show clearance dimensions at critical locations.
      b. Show dimensions of spaces required for operation and maintenance.
      c. Show interfaces with other work, including structural support.

C. Test Reports:
   1. Submit test reports, which have been signed and dated by the firm performing the test.
   2. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.

D. Required Equipment and Shop Drawing Submittals:
   1. Provide a submittal schedule with bid.
   2. Provide equipment submittals for each item of equipment specified or scheduled in the Contract Documents.
   3. Submittal schedule shall show each item of equipment, applicable section of the Specifications where it is described, applicable drawing number and schedule name where it is scheduled, date of Contractor’s proposed submittal to the Owner's Representative, required date of receive submittal from the Owner’s Representative and schedule order date.
   4. Provide a HVAC Shop Drawing Schedule for submission to the Owner’s Representative with the Submitted Schedule.

1.10 COMPATIBILITY

A. General: Provide products, which are compatible with other products of the HVAC work, and with other work, requiring interface with the HVAC work.
B. Power Characteristics: Where power characteristics are not stated in Division 23 Sections, refer to the Sections of Division 26 and the Electrical Drawings for the power characteristics of each power driven item of HVAC equipment. Coordinate available power with Electrical Contractor before ordering equipment. HVAC Contractor shall be responsible for ordering equipment to meet the available power characteristics. If there is a conflict between Division 23 documents and Division 26 documents, provide a written notification to the Owner’s Representative for direction. Do not order equipment prior to determining the proper electrical service. No contact cost adjustment will be allowed for equipment ordered in conflict with the available power characteristics.

C. Mechanical units shall operate on the power supply as specified on the equipment schedule. Power and control connections shall have terminal block or terminal strip connections.

1.11 RECORD DRAWINGS

A. Drawings:
   1. Record of Project progress: Maintain drawings available at the job site for inspection. Keep an accurate, legible and continuously updated record of installed locations and all project revisions other than revised drawings issued by the Architect, including source and date of authorization. Utilize only contract drawing symbols for recording the work. Drawing notations to be sufficiently clear in the representation of the work, for utilization by a CADD operator (drafts person) who is not necessarily familiar with the installed work.
   2. Record of Installation: At the conclusion of the work, deliver one (1) set of updated drawings to the Owner’s Representative for review. Following the review, Contractor shall have incorporated by a competent CADD operator all of the installed data represented on the project progress drawings.
   3. Include in Record Drawings the Following:
      a. Revisions, including sketches, bulletins, change orders, written addenda and directives, clarifications and responses generated by requests for information (RFIs), regardless of source of the revision.
      b. Location and configuration of equipment with related housekeeping pads.
      c. Physical routing of ductwork, exposed and above ceilings with locations of fire dampers, combination fire/smoke dampers, smoke detectors, diffusers, registers, grilles, air terminal units, appurtenances, etc., plainly marked and identified.
      d. Location of room thermostats, humidistats and sensors.
      e. Physical routing of piping, underground, exposed and above ceiling with locations of valves and accessories plainly marked and identified.
      f. Location of piping below building and on exterior, valves, manholes, appurtenances and stub outs dimensioned from buildings and permanent structures, both horizontally and vertically.
      g. Location of wall and ceiling access panels.

B. Temperature Control Drawings:
   1. Indicate As-Built Conditions of Work Under This Contract Including:
      a. Ladder wiring diagram.
      b. Schematic diagrams.
      c. One line system diagram.
      d. Schematic of equipment with control devices located and identified.
      e. Wiring or tubing termination diagrams.
      f. Floor plan indicating all device locations, panels, etc.
      g. Control sequences.

C. Acceptance: As a condition for acceptance of the work, deliver two (2) sets of Auto CAD Latest Version CDs and one set of signed and dated reproducible drawings to the Owner’s Representative and obtain a receipt.
1.12 OPERATING AND MAINTENANCE DATA

A. Refer to Division 01 requirements.

B. Submission:
   1. Submit three typed and bound copies of Operating and Maintenance (O&M) Manuals prior to scheduling systems demonstrations for the Owner’s Representative, as specified in Division 01.
   2. Bind each Maintenance Manual in one or more vinyl covered, 3-ring binders, with pockets for folded drawings.
      a. Mark the spine of each binder with system identification and volume number.

C. Required Contents:
   1. Manuals shall have index with tab dividers for each major equipment section to facilitate locating information on a specific piece of equipment.
   2. Identifying data within each section with drawing code numbers as they appear on Drawings and Specifications. Include as a minimum the following data:
      a. Alphabetical list of system components, with the name, address and 24 hour telephone number of the company responsible for servicing each item during the first year of operation. Include point of contact for company.
      b. Operating instructions for complete system including:
         1) Emergency procedures for fire and failure of major equipment.
         2) Major start, operation and shut down procedures.
      c. Maintenance Instructions for Each Piece of Equipment Including:
         1) Equipment lists.
         2) Proper lubricants and lubricating instructions for each piece of equipment.
         3) Necessary cleaning, replacement and/or adjustment schedule.
         4) Product data.
         5) Installation instructions.
         6) Parts list.
         7) Temperature control diagrams and O&M information as specified above (as-built).
      d. Marked or changed prints locating concealed parts and variations from the original system design (as-built drawings).
      e. Balancing report.
      f. Valve schedule and associated piping schematics. See Section 230553, HVAC IDENTIFICATION.
      g. Copies of any extended equipment warranties which are greater than one year.

1.13 WARRANTIES

A. The warranty period is two years after Date of Acceptance.
   1. During this period, provide labor and materials as required to repair or replace defects in the HVAC system at no additional cost to the Owner. Provide certificate with O&M Manual submittal, which guarantees same-day service response to Owner’s call for all such warranty service.
   2. Provide certificate for such items of equipment, which have warranties in excess of one year. Insert copies in O&M Manuals.
   3. Provide extended manufacturers warranties to cover two years from date of acceptance if standard warranty starts any time prior to that date.
   4. Provide factory trained service personnel for all warranty work on the Building Automation and Automatic Temperature Control System.
   5. At time of bid, submit additional costs for extended warranties for principal equipment (e.g. AHUs, indirect evaporative units, heat exchangers, etc.).

B. Provide longer warranties where specified in individual specification sections.
C. Refer to Division 01 for additional requirements.

1.14 SPARE PARTS SPECIAL TOOLS
A. Deliver spare parts to the Owner’s Representative and obtain receipts at the time operating instructions are given to the Owner’s personnel.
B. Include the Following:
   1. V-Belts: One complete set of each size.
   2. Fuses: Each type used for all equipment utilizing fuses. Quantity 10%, but not less than two.
   3. Pilot Light Lamps: Each type used on the project. Quantity of 10%, but not less than two.
   4. Special Tools: Furnish special tools required for assembly, adjustment, setting or maintenance of equipment if such tool is not readily available on the commercial tool market.
   5. Maintenance Paint: Furnish one can of touch-up paint for each different factory finish, which is to be the final finished surfaced of the product.
   6. Alternate Parts: Under the individual HVAC sections, there are listed spare parts to be furnished under a bid alternate. Should the alternate be accepted, such spare parts shall be similarly delivered to the Owner.

1.15 SYSTEM ACCEPTANCE
A. Acceptance shall be contingent upon completion of final review and correction of all deficiencies. Satisfactory completion of the operational tests, which shall demonstrate compliance with all performance criteria, and the requirements of the Contract Documents.
B. Request a Final Review Prior to System Acceptance After Completion of the Following:
   1. Installation of all systems required by Contract Documents.
   2. Submission and acceptance of service manuals.
   3. Identification.
   4. Cleaning.
   5. Satisfactory operation of all systems for a period of one week.

1.16 MANDATORY GOVERNING PROVISION
A. Omissions of words or phrases, such as “the Contractor shall”, “in conformity with”, “shall be”, “as noted on the Drawings”, “according to the Drawings”, “an”, “the”, and “all” are intentional.
B. Omitted words or phrases shall be supplied by inference.

1.17 OWNER FURNISHED EQUIPMENT
A. All equipment called out in the Specifications or shown on the Drawings as “Owner Furnished Equipment” shall be installed and connected under this contract. Provide rough-ins for all future connections indicated, unless otherwise specifically indicated on the Drawings.

1.18 TEMPORARY FACILITIES
A. Light, heat, power, etc.:
   1. Contractor shall be responsible for providing temporary electricity, heat and other facilities as specified in Division 01.
   2. Contractor shall be responsible for maintaining the equipment in an as-new condition. Equipment will not be turned over to the Owner until it is brought up to as-new condition.
   3. Contractor shall be responsible for maintaining acceptable indoor air quality in adjacent occupied spaces.
B. Use of permanent building for temporary heating or cooling:
1. Permanent building equipment shall not be used without written permission from the Owner's Representative. If this equipment is used for temporary heating, cooling, or ventilation, it shall be adequately maintained per manufacturer's instructions and protected with filters, strainers, controls, relief, etc. The Contractor shall protect all equipment and systems as directed by the Owner’s Representative. The warranty period shall not start until the equipment is turned over to the Owner for his/her use. The Contractor shall provide extended warranties for parts and labor for such equipment. Equipment shall not be turned over to the Owner until the temperature controls have been tested and accepted by the Owner’s Representative.

1.19 SAFETY PROVISIONS

A. Equipment Nameplates: Provide power-oriented HVAC equipment with a permanent nameplate attached by the manufacturer, indicated:
   1. The manufacturer.
   2. Product name.
   3. Model number.
   4. Serial number.
   5. Speed.
   6. Capacity.
   7. Power characteristics.
   8. Labels of testing, or inspecting agencies 9. Other similar data.

B. Where manufacturer affixed nameplate is not available, Contractor shall fabricate and attach nameplate.

C. Guards:
   1. Unless equivalent guards are provided integral with the equipment, enclose each belt drive (including sheaves) on both sides in a galvanized, one inch, mesh screen of No. 18 gauge steel wire or expanded metal, fastened to an approved, structural steel frame, securely fastened to the equipment or floor.
   2. Provide tachometer holes at shaft centers. Unless equivalent guards are provided integral with the equipment, install a solid guard of No. 20 gauge galvanized steel over the coupling of each item of direct-driven equipment.
   3. Sides are not required on these guards except to ensure rigidity.

PARTS 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 INSTALLATION GENERAL REQUIREMENTS

A. Furnish, apply, install, connect, erect, clean, and condition manufactured materials and equipment as recommended in manufacturer’s printed directions (maintained on job site during installation).

B. Provide all attachment devices and materials as necessary to secure materials together or to other materials.

C. Make allowances for ample and normal expansion and contraction for all building components and piping systems that are subject to such.

D. Install materials only when conditions of temperature, moisture, humidity and conditions of adjacent building components are conducive to achieving the best installation results.

E. Erect, install and secure components in a structurally sound and appropriate manner.
F. Where necessary, temporarily brace, shore, or otherwise support members until final connections are installed.

G. Leave all temporary bracing, shoring, or other structural supports in place as long as practical for safety and to maintain proper alignment.

H. Handle materials in a manner to prevent scratching, abrading, distortion, chipping, breaking, or other disfigurement.

I. Conduct work in a manner to avoid injury or damage to previously placed work.

J. Any work so impaired or damaged shall be replaced at no expense to Owner.

K. Fabricate and install materials true to line, plumb and level.

L. Leave finished surfaces smooth and flat, free from wrinkles, wraps, scratches, dents and other imperfections.

M. Furnish materials in longest practical lengths and largest practical sizes to avoid all unnecessary jointing.

N. Make all joints secure, tightly fitted, and as inconspicuous as possible by the best accepted practice in joinery and fabrication.

O. Consult the Owner’s Representative for mounting height or position of any unit not specifically indicated or located on Drawings or specified in Specifications.

P. Job mixed multi-component materials used in the work shall be mixed in such regulated and properly sized batches that material can be used before it begins to ‘set’.

Q. Mixing of a partially ‘set’ batch with another batch of fresh materials will not be accepted and entire batch shall be discarded and removed from site.

R. Clean all mixing tools and appliances that can be contaminated prior to mixing of fresh materials.

S. In addition to the above, refer to each Section of the Specifications for additional installation requirements for the proper completion of all work.

3.2 COORDINATION OF HVAC INSTALLATION

A. Inspection and Preparation:
   1. Examine the work interfacing with HVAC work, and the conditions under which the work will be performed, and notify the Owner’s Representative of conditions detrimental to the proper completion of the work at original contract price.
   2. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Layout:
   1. Layout the HVAC work in conformity with the Contract Drawings, Coordination Drawings and other Shop Drawings, product data and similar requirements so that the entire HVAC plant will perform as an integrated system, properly interfaced with other work recognizing that portions of the work are shown only in diagrammatic form.
   2. Where coordination requirements conflict with individual system requirements, comply with the Owner’s Representative decision on resolution of the conflict.
   3. Take necessary field measurements to determine space and connection requirements.
   4. Provide sizes and shapes of equipment so the final installation conforms to the intent of the Contract Documents.
   5. Provide necessary fittings to create offsets as required to coordinate with building structure and other trades, even if fittings are not shown on the Contract Drawings.
C. Integrate the HVAC work in ceiling spaces with suspension system, light fixtures and other work, so that required performance of each will be achieved.

3.3 PRODUCT INSTALLATION

A. Manufacturer’s Instructions:
   1. Except where more stringent requirements are indicated, comply with the product manufacturer’s instructions and recommendations.
   2. Consult with manufacturer’s technical representatives, who are recognized as technical experts, for specific instructions on special projects conditions.
   3. If conflict exists, notify the Owner’s Representative in writing and obtain his instruction before proceeding with the work in question.

B. Movement of Equipment:
   1. Wherever possible, arrange for the movement and positioning of equipment so that enclosing partitions, walls and roofs will not be delayed or need to be removed.
   2. Otherwise, advise Contractor of opening requirements to be maintained for the subsequent entry of equipment.

C. Heavy Equipment:
   1. Coordinate the movement of heavy items with shoring and bracing so that the building structure will not be overloaded during the movement and installation.
   2. Where HVAC products to be installed on the existing roof are too heavy to be hand-carried, do not transport across the existing roof deck. Position by crane or other device so as to avoid overloading or otherwise damaging the roof deck.

D. Clearances:
   1. Install Piping and Ductwork:
      a. Straight and true.
      b. Aligned with other work.
      c. Close to walls and overhead structure (allowing for insulation).
      d. Concealed, where possible, in occupied spaces.
      e. Out-of-the-way with maximum passageway and headroom remaining in each space.
   2. Do not obstruct windows, doors and other openings.
   3. Give the right-of-way to piping systems required to slope for drainage (over other service lines and ductwork).

E. Access:
   1. Provide for Removal, without Damage to Other Parts, of:
      a. Coils.
      b. Shafts.
      c. Fan wheels.
      d. Drives.
      e. Filters.
      f. Strainers.
      g. Bearings.
      h. Control components.
      i. Other parts requiring periodic replacement or maintenance.
   2. Connect equipment for ease of disconnecting with minimum of interface with other work.
   3. Provide unions where required.
   4. Locate operating and control equipment and devices for easy access.
   5. Provide access panels where equipment or devices are concealed by non-accessible finishes and similar work.
6. Ensure grease fittings for equipment are readily visible and accessible. Extend fittings when necessary.

3.4 EQUIPMENT SERVICE ACCESS AND MAINTAINABILITY

A. A “maintenance access” zone (vertically and horizontally) is to be defined and called out on coordination and shopdrawings and maintained through final construction. The maintenance access zone shall match the manufacturer’s recommendations and shall extend from the top of the unit or equipment to the finished floor without obstruction other than removable ceiling tile or moveable furnishings.

1. Coordination with architectural, mechanical, electrical, fire protection and plumbing equipment is required; no service access shall be blocked.

B. Accessible equipment is defined as:

1. Being capable of being reached without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformer, piping, ductwork, light fixture, structural members, conduits, fixed equipment, casework, and fixed furnishings.

2. Maximum access height of equipment:
   a. For equipment above lay-in ceilings: No more than 4’ above ceiling grid or an absolute maximum of 14’ above the finished floor.
   b. For equipment above hard ceilings, provide minimum 24”x24” access panel. Locate equipment no more than 4’ above ceiling height.

3. Equipment requiring service access shall include but not be limited to:
   a. Fire dampers/actuators
   b. Duct access doors
   c. VAV boxes
   d. Fan coil units (filter and controls)
   e. Damper actuators
   f. Valve actuators
   g. Control valves
   h. Isolation Valves
   i. Sensors, switches and other control devices or instrumentation
   j. Motors
   k. Pumps
   l. Air bleeders or air vents
   m. Strainers
   n. Compressors
   o. Meters

4. Where duct balancing dampers or isolation valves are above 16’ above the finished floor and cannot be easily accessed from below, provide remote means for balancing and isolation.

5. Pull space for coils and heat exchanger tube bundles needs to be defined and shown on plans and equipment elevation views. Isolation valves need to be located outside the coil pull space to allow for removal without draining down the entire system.

3.5 PROTECTION OF WORK

A. Provide protection against dust migration, rain, wind, storms, frost, or heat so as to maintain all work, materials, apparatus and fixtures free from injury or damage.

B. At the end of each day’s work, cover all new work likely to be damaged.

C. Do not interrupt the integrity of the building security overnight.

D. Refer to Division 01 for additional requirements.
E. All pipe ends, valves, ducts and equipment left unconnected shall be capped, plugged or otherwise properly protected to prevent damage and the intrusion of foreign matter.

F. Do not allow any fans in HVAC system to operate before the area served by the fan has been cleaned and vacuumed of all debris and dust which might enter the system. If any air handling system is to be used for temporary heating, cooling or ventilating as stated in Paragraph “Temporary Facilities” herein; a construction filter with minimum 20% efficiency must be provide at each return air grille and opening.

G. Any equipment, duct or piping systems found to have been damaged or contaminated above “MILL” or “SHOP” conditions shall be replaced or cleaned to the Owner’s Representative’s satisfaction.

H. Provide initial water seal fill for all condensate traps, or similar traps.

3.6 OBJECTIONABLE NOISE AND VIBRATION
   A. HVAC equipment and piping system shall operate without objectionable noise and vibration, as determined by the judgment of the Owner’s Representative.
   B. If objectionable noise and vibration should be produced, make necessary changes or additions required to produce satisfactory result without additional cost to the Owner.

3.7 CLOSING-IN OF UN-INSPECTED WORK
   A. Do not allow or cause any work to be covered up or enclosed until inspected, tested and approved.
   B. Should any work be enclosed or covered up before such inspection and test, Contractor shall, at his/her own expense, uncover work and after it has been inspected, tested and approved, make repairs with such materials as necessary to restore his/her work and that of other Divisions to original and proper condition.

3.8 CLEANING
   A. After installation is complete, clean all systems as indicated below.
   B. Ductwork, Piping and Equipment To Be Insulated: Clean exterior thoroughly to remove rust, plaster, cement and dirt before insulation is applied.
   C. Ductwork, Piping and Equipment To Be Un-insulated: Clean exterior thoroughly to remove rust, plaster, cement, dirt and other foreign substances.
   D. Ductwork, Piping and Equipment To Be Painted: Clean exterior to be exposed in completed structure. Remove rust, plaster, cement and dirt by wire brushing. Remove grease, oil and other foreign materials by wiping with clean rags and suitable solvents.
   E. During Progress of Work: Carefully clean up the premises and keep all portions of the building free of debris.
   F. Chrome or Nickel Plated Work: Thoroughly polish.

3.9 DAMAGE RESPONSIBILITY
   A. Contractor shall be responsible for damage to the grounds, buildings or equipment and the loss of refrigerants, fuels or gases, caused by leaks or breaks in pipes for equipment furnished or installed under this Division.
3.10 PRELIMINARY OPERATION
A. The Owner's Representative reserves the right to operate portions of the HVAC system on a preliminary basis without voiding the guarantee or relieving the Contractor of his/her responsibilities.

3.11 OPERATION TESTS
A. Before operational tests are performed, demonstrate to the Owner's Representative that systems and components are complete and fully charged with operating fluid and lubricants. Systems shall be operable and capable of maintaining continuous uninterrupted operation during the operating and demonstration period.

B. After systems have been completely installed, connections made, and tests completed, operate the systems continuously for a period of five working days during the hours of a normal working day.

C. Control system shall be completely operable with settings properly calibrated and adjusted.

D. Rotating equipment shall be in dynamic balance and alignment.

E. Tests required in various sections herein shall be completed.

F. Notify the Owner’s Representative, in writing two weeks in advance of this operational period. G. This operational test may be concurrent with instruction of the Owner's operating personnel.

3.12 COMPLIANCE TESTS
A. Conduct tests for individual components, such as chiller, boiler, cooling tower, air handling unit, air terminal units, fans, etc. of all portions of the installation as may be required by the various Sections of this Division to comply with the Contract Documents. Tests shall be made in the presence of the Owner's Representative. Costs of tests shall be borne by the Contractor. Contractor shall provide all instruments, equipment, labor and materials to complete the tests. These tests may be required at any time between the installation of the work and the end of the warranty period. Should these tests expose any defective materials, poor workmanship or variance with requirements of the Contract Documents, Contractor shall make any changes necessary and remedy any defects at no cost to the Owner.

END OF SECTION
SECTION 230513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 COORDINATION
   A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
      1. Motor controllers.
      2. Torque, speed, and horsepower requirements of the load.
      3. Ratings and characteristics of supply circuit and required control sequence.
      4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS
   A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
   B. Comply with current NEMA MG 1 unless otherwise indicated.
   C. Comply with current IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS
   A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
   B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS
   A. Description: NEMA MG 1, Design B, medium induction motor.
   B. Efficiency: Premium efficient, as defined in NEMA MG 1.
   C. Service Factor: 1.15.
   D. Multispeed Motors: Variable torque.
      1. For motors with 2:1 speed ratio, consequent pole, single winding.
      2. For motors with other than 2:1 speed ratio, separate winding for each speed.
   F. Bearings: Re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
   G. Temperature Rise: Match insulation rating.
   H. Insulation: Class F.
I. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

K. Shaft: Grounded
   1. Provide Aegis SGR or approved equivalent for shaft grounding.
   2. Install per manufacturer instructions.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   5. Shaft: Grounded

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.
   5. Brushless DC (ECM)

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

F. Brushless DC (ECM) motor requirements are specified in Division 23 equipment sections.

2.6 ELECTRICAL CONNECTION

A. Refer also to Mechanical Electrical Coordination schedule for electrical connection requirements including but not limited to starters, disconnects, wiring, installation, interconnections, etc.
PART 3 EXECUTION

END OF SECTION
SECTION 230514
VARIABLE-FREQUENCY MOTOR CONTROLLERS (VSD/VFD)

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes separately enclosed, preassembled, combination VSDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.
   B. Variable Frequency Motor Controller Bypass
   C. Multi-motor VFMC Configurations
   D. VSD Filtering

1.3 DEFINITIONS
   A. CE: Conformite Europeene (European Compliance).
   B. CPT: Control power transformer.
   C. DDC: Direct digital control.
   D. EMI: Electromagnetic interference.
   E. LED: Light-emitting diode.
   F. NC: Normally closed.
   G. NO: Normally open.
   H. OCPD: Overcurrent protective device.
   I. PID: Control action, proportional plus integral plus derivative.
   J. PWM: Pulse Width Modulation
   K. RFI: Radio-frequency interference.
   L. VSD: Variable-frequency motor controller.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type and rating of VSD indicated.
      1. Include dimensions and finishes for VSDs.
      2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   B. Shop Drawings: For each VSD indicated.
      1. Provide coversheet indicating project title, project location, and vendor contact information.
      2. Organize submittal into logical sections and provide table of contents.
      3. Provide itemized bill of materials indicating model number and quantity for each product.
      4. On datasheets with multiple products, indicate which product is provided under this project.
5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.

6. Manufacturers' catalog sheets with complete technical data for each item being furnished.

7. Include mounting and attachment details.

8. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

9. Include diagrams for power, signal, and control wiring.

10. Detailed installation drawings including:
   a. Control terminals, designation, and locations
   b. Power circuit diagram identifying disconnects, bypass disconnect, filters or isolation transformer, and motor.
   c. Internal electrical wiring and control circuit diagram
   d. Wiring of auxiliary devices and optional inputs.
   e. Interconnection to harmonic filter traps, line reactors, and dV/dT filters.

11. Furnish a technical brochure or matrix detailing standard VSD features.
   a. Motor horse power and amperage rating.
   b. Power factor at full load.
   c. Input power characteristics.
   d. Full load Efficiency.
   e. Control interface requirements.
   f. Status display system.
   g. Options not listed in specifications.

12. Exceptions and variations from the specification.

13. Include steady state and fault current ratings.

14. Filter characteristics:
   a. Dimensional drawings with installed weight for each size.
   b. Power input characteristics.
   c. Wiring diagram

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Required working clearances and required area above and around VSDs.
   2. Show VSD layout and relationships between electrical components and adjacent structural and mechanical elements.
   3. Show support locations, type of support, and weight on each support.
   4. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Product Certificates: For each VSD from manufacturer.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VSDs to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
   b. Manufacturer's written instructions for setting field-adjustable overload relays.
   c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
   d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
   e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Indicating Lights: Two of each type and color installed.
   4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
   5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE
A. Provide Variable Frequency Controllers suitable for operating with NEMA Design B induction motors. VSD's shall be compatible with standard 3 phase high efficiency motors.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.9 DELIVERY, STORAGE, AND HANDLING
A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and store according to manufacturer's requirements.
B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VSDs, including clearances between VSDs, and adjacent surfaces and other items.

1.10 WARRANTY
A. Special Warranty: Manufacturer agrees to repair or replace VSDs that fail in materials or workmanship within specified warranty period.
   1. VSD Warranty Period: Five years from date of Substantial Completion.
   2. Filter Warranty Period: Three years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Variable Frequency Motor Controller Manufacturers: Subject to compliance with requirements, provide products by one of the following:
B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   1. ABB Power Distribution, Incorporated; ABB Control, Incorporated Subsidiary.
   2. Danfoss
   3. Yaskawa

C. Harmonic Trap Filters, dV/dT, Filters, and Input Line Reactor Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trans Coil Inc.
   2. MTE
   3. Myron Zucker
   4. Schaffner

2.2 VSD SYSTEM DESCRIPTION AND RATINGS

A. General Requirements for VSDs:
   1. VSDs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

B. Application: Variable torque.

C. VSD Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means where integrated on drawings and schedules and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VSD input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 5 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VSD frequency rating.
   4. Minimum Efficiency: 97 percent at 100 percent speed and greater than 85 percent at 50 percent speed.
   5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
   6. Minimum Power Factor: 95 percent at 100 percent speed and greater than 90 percent at 25 percent speed.
   7. Bus capacitance voltage ratings
      a. 208-240V VSD’s shall have a minimum bus voltage capacitance of 400 VDC.
b. 460-480V VSD’s shall have a minimum bus voltage capacitance of 800 VDC.

8. IGBT ratings
   a. 208-240V VSD’s shall be equipped with IGBT’s that have a minimum $V_{ce}$ rating of 600V.
   b. 460-480V VSD’s shall be equipped with IGBT’s that have a minimum $V_{ce}$ rating of 1200V.


10. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 120 deg F.

11. Humidity Rating: Less than 95 percent (noncondensing).

12. Altitude Rating: Not exceeding 3300 feet (1000 m).

13. Audible noise shall not exceed 85 dBA measured at a point 3 feet from the VSD.


15. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

16. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.

17. Speed Regulation: Plus or minus 5 percent.

18. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.

19. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Converter Section
   1. Utilize six-pulse full wave diode or PWM bridge design to convert fixed voltage and frequency AC line power to fixed DC voltage.
   2. Operation of the converter section shall be unaffected by phase rotation.
   3. Input shall have MOVs (Metal Oxide Varistors) for surge protection.

H. DC Bus Section
   1. DC bus shall include a minimum 5% integrated DC link reactors to minimize harmonic distortion.
   2. DC bus shall have a passive capacitive filter to minimize ripple and maximize power-loss ride through.
   3. Provide balance discharge resistors to equalize charge voltage and permit safe discharge of capacitors upon loss of power.

I. Inverter Section
   1. Utilize isolated-gate bipolar transistors (IGBTs) to convert DC bus voltage to tree phase, variable frequency, and sinusoidal coded PWM waveform to control the motor. Six step and current source drives are not acceptable.
   2. PWM switching frequencies (Carrier Frequency): Selectable; 1.0 to 12 kHz. Factor set the carrier frequency at 3 kHz.
   3. VSD shall be capable of skipping over minimum of three critical frequencies to prevent the VSD from operating the load continuously at unstable speeds or undesirable noise conditions. VSD shall accelerate or decelerate through these ranges, but not be allowed to operate consistently in these ranges.

J. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

K. Isolated Control Interface: Allows VSDs to follow remote-control signal over a minimum 40:1 speed range.

L. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 0.1 to 999.9 seconds.
   4. Deceleration: 0.1 to 999.9 seconds.
   5. Current Limit: 30 to minimum of 150 percent of maximum rating.
M. Self-Protection and Reliability Features:
   1. Surge Suppression: Factory installed as an integral part of the VSD, complying with UL 1449 SPD, Type 1 or Type 2.
   2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   4. Inverter overcurrent trips.
   5. VSD and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VSDs and motor thermal characteristics, and for providing VSD over-temperature and motor-overload alarm and trip; settings selectable via the keypad.
   6. Critical frequency rejection, with three selectable, adjustable deadbands.
   7. Instantaneous line-to-line and line-to-ground overcurrent trips.
  10. Short-circuit protection.
  11. Motor-overtemperature fault.

N. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

O. Bidirectional Autospeed Search: Capable of starting VSD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

P. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

Q. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

R. Integral Input Disconnecting Means and OCPD: UL 489, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
   1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VSD input current rating, whichever is larger.
   2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
   3. Auxiliary contacts “a” and “b” arranged to activate with circuit-breaker handle.
   4. NC and NO alarm contact that operates only when circuit breaker has tripped.

2.3 PERFORMANCE REQUIREMENTS

A. If audible motor noise created by the VSD exceeds 5 dB of the motor noise generated when the motor is directly connected to line power through an across the line starter, the VSD supplier shall remedy the situation at no cost.

2.4 CONTROLS AND INDICATION

A. Electrically isolate the following circuit systems from the main power circuits:
   1. Internal control circuiting regulating DC bus voltage and inverter output frequency.
   2. Circuitry supplying various microprocessors, controllers, sensors, etc., which provide the VSD’s operational and safety features.

B. Provide devices which will limit the following operational parameters:
   1. Permit field adjustment of minimum and maximum output frequency. The range shall be adjustable from 4 Hz to 60 Hz.
2. Permit field adjustment of the acceleration rate intervals from 0% to 100% speed. Unless noted otherwise, set full range acceleration rates initially at 60 seconds.
3. Permit field adjustment of the deceleration rate intervals from 0% to 100% speed. Unless noted otherwise, set full range deceleration rate at 60 seconds.

C. Status Lights: Door-mounted LED indicators displaying the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.

D. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
      a. Control Authority: Supports at least four conditions: Off, local manual control at VSD, local automatic control at VSD, and automatic control through a remote source.

E. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last six faults with time and date stamp for each.

F. Indicating Devices: Digital display mounted flush in VSD door and connected to display VSD parameters including, but not limited to:
   1. Output frequency (Hz).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (V dc).
   9. Set point frequency (Hz).
   10. Motor output voltage (V ac).
   11. Operating hours (with reset function)
   12. Kilowatt hours (with reset function)

G. VSD Monitoring and Alarming
   1. The VSD controller shall have the ability to display the following alarms and notifications at the VSD display as well as the relay to the building automation system via communications interface.
      a. Status indicators
         1) On/Off status
         2) Input power status
         3) Input power fault
         4) Over-current fault
5) Ground fault
6) Under-voltage
7) Over-voltage
8) Over-temperature fault
9) Motor over-load fault
10) Motor under-load fault
11) DC braking
12) Emergency off
13) Retry
14) Restart

b. Alarms
1) Over-voltage pre-alarm
2) Over-current pre-alarm
3) Under-voltage
4) Overheat pre-alarm
5) Overload pre-alarm
6) Communications Error
7) Tuning Error
8) Point setting alarm
9) Clear enabling indication
10) Emergency Stop Enabling indication
11) Setting Error Alarm
12) Momentary power loss slowdown
13) Lower-limit time-out stop
14) VSD in bypass

c. Faults
1) Over-current (start up)
2) Over-current (Acceleration, Deceleration, and Running)
3) U-phase short
4) V-phase short
5) W-phase short
6) Over-voltage (Acceleration, Deceleration, and Running)
7) Under-voltage
8) Over-frequency
9) Under-frequency
10) Over-heat
11) Over-heat (external)
12) Over-torque
13) Inverter overload
14) Motor overload
15) Ground Fault
16) Input phase failure
17) Output phase failure
18) Sequence error
19) Speed error
20) V/Hz control error
21) Communications error
22) Logic voltage error
23) Self-diagnostics alarm
24) VSD in bypass

d. VSD shall be equipped of automatic reset and restart circuit which will restart the motor 20 seconds after self-protection shut down. The VSD shall attempt no more than 5 automatic restarts. Each successive attempt shall occur at least 120 seconds after the last.
H. Control Signal Interfaces (I/O):
   1. Electric Input Signal Interface:
      a. A minimum of two programmable analog inputs: 0- to 10-V dc and 4- to 20-mA dc.
      b. A minimum of six multifunction programmable digital inputs.
   2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
      a. 0- to 10-V dc.
      b. 4- to 20-mA dc.
      c. Potentiometer using up/down digital inputs.
      d. Fixed frequencies using digital inputs.
      e. Coordinate additional input requirements with Division 23 and 25 contractors. Refer also to 230933 Sequence of Operation and mechanical drawings for additional details.
   3. VSD shall be equipped with a 120 VAC safety circuit for fire alarm system shutdown. Confirm this requirement is acceptable with ASU Facilities Management staff before releasing approved submittals.
   4. Output Signal Interface: A minimum of two programmable analog output signal(s) 0- to 10-V dc and 4- to 20-mA dc, which can be configured for any of the following:
      a. Output frequency (Hz).
      b. Output current (load).
      c. DC-link voltage (V dc).
      d. Motor torque (percent).
      e. Motor speed (rpm).
      f. Set point frequency (Hz).
      g. Energy consumption (kW)
      h. Coordinate additional output requirements with Division 23 and 25 contractors. Refer also to 230933 Sequence of Operation and mechanical drawings for additional details.
   5. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
      a. Motor running.
      b. Set point speed reached.
      c. Fault and warning indication (overtemperature or overcurrent).
      d. PID high- or low-speed limits reached.
      e. Coordinate additional output requirements with Division 23 and 25 contractors. Refer also to 230933 Sequence of Operation and mechanical drawings for additional details.
I. Communications Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VSD settings shall be retained within VSD’s nonvolatile memory.
   1. Communication Interface: Comply with a minimum of ASHRAE 135. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

2.5 LINE CONDITIONING AND FILTERING

A. Provide UL listed Filters for the application.
B. Filters shall be located adjacent to the VSD or contained in a common enclosure as the VSD it is serving.
C. Filter enclosures shall be meet the same requirements as specified for VSD’s.
D. Input Line Conditioning
   1. Provide a 5% input line reactor on the input of all VSD’s greater than 40 HP in addition to any internal line reactors and filters.
2. Provide harmonic filters on the input of all VSD’s serving motors greater than 40 HP
   a. Provide contactor within filter to disconnect capacitors from line power to the VSD when
      signal is received from the VSD. VSD shall be programed to disconnect capacitors at 25% load
      and energize capacitors at 30% load.
   b. Provide contactor to bypass entire filter when VSD has been bypassed. Provide interlock
      between bypass switch and contactor.
3. VSD disconnecting means shall disconnect power to input filter and reactors.

F. Output Filtering: Provide dV/dT filters for all locations where conductors between the motors and
   VSD are 75 feet or longer.

G. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.6 BYPASS REQUIREMENTS (ALL DRIVES)

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit,
   manually, automatically, or both. Selector switches set modes and indicator lights indicate mode
   selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely
   disconnected from power converter.
   1. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.

B. Bypass Mode: Manual operation only; requires local operator selection at VSD. Transfer between
   power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero
   speed.

C. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or
   the bypass controller; with input isolating switch and barrier arranged to isolate the power converter
   input and output and permit safe testing and troubleshooting of the power converter, both energized
   and de-energized, while motor is operating in bypass mode.
   3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe
      troubleshooting and testing of the power converter, both energized and de-energized, while
      motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Full-voltage (across-the-line) for motors less than 40 HP. Re-
   duced-voltage (autotransformer) for motors 40 HP and larger type.
   1. NORMAL/BYPASS selector switch.
   2. HAND/OFF selector switch.
   3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VSD while the motor is run-
      ning in the bypass mode.
      a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufac-
         turer's standard matching control power or line voltage.
      b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to
         allow inspection and replacement without disturbing line or load wiring.
   5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses with
      CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating,
      and control devices.
      a. CPT Spare Capacity: 50VA.
      b. Bimetallic Overload Relays:
         1) Inverse-time-current characteristic.
         2) Class 10 tripping characteristic.
         3) Heaters in each phase matched to nameplate full-load current of actual protected mo-
            tor and with appropriate adjustment for duty cycle.
4) Ambient compensated.
5) Automatic resetting.
   c. NC and NO isolated overload alarm contact.
   d. External overload, reset push button.

2.7 OPTIONAL FEATURES
A. Multiple-Motor Capability: VSD suitable for variable-speed service to multiple motors. Overload protection shuts down VSD and motors served by it, and generates fault indications when overload protection activates.
   1. Size VSD to accommodate 125% of the largest motor full load amps (FLA) plus 100% of the remaining motors FLA.
   2. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
B. Damper control circuit with end-of-travel feedback capability.
C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VSD resumes normal operation.
D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.
E. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
F. Remote digital operator kit.
G. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.8 ENCLOSURES
A. VSD Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 12.
   2. Outdoor Locations: Type 3R.
   3. Other Wet or Damp Indoor Locations: Type 4.
B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VSD as “Plenum Rated.”
C. Internal cooling fans and fillers shall be provided where required to maintain drive operating temperature.
D. Internal heating elements shall be provided where required to maintain drive operating temperature.
E. Provide lifting provisions for units weighing more than 80 pounds.
F. All units shall be provided with a grounding lug.
G. The enclosure shall have a through-the-door interlocking handle with padlocking provisions.
H. Wall units shall be provided with necessary mounting brackets.

2.9 ACCESSORIES
A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VSD enclosure cover unless otherwise indicated.
   1. Push Buttons: Covered.
4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Reversible NC/NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable [pneumatic] [solid-state] time-delay relays.


E. Supplemental Digital Meters:
   1. Elapsed-time meter.
   2. Kilowatt meter.

F. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

G. Spare control-wiring terminal blocks.

2.10 ELECTRICAL CONNECTION
A. Refer also to Mechanical Electrical Coordination schedule for electrical connection requirements including but not limited to starters, disconnects, wiring, installation, interconnections, etc.

2.11 SOURCE QUALITY CONTROL
A. Testing: Test and inspect VSDs according to requirements in NEMA ICS 61800-2.
   1. Test each VSD while connected to a motor that is comparable to that for which the VSD is rated.
   2. Verification of Performance: Rate VSDs according to operation of functions and features specified.

B. VSDs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 EXECUTION
3.1 EXAMINATION
A. Examine areas, surfaces, and substrates to receive VSDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VSD before installation. Reject VSDs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VSD installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

E. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 COORDINATION

A. The VSD manufacturer shall obtain information about any critical speeds, which must be locked out in the VSD controls to avoid noise and vibration caused by harmonic resonance in the mechanical system.

B. Contractor shall coordinate final VSD locations with VSD manufacturer and mechanical equipment layouts.

3.3 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Roof-Mounting Controllers: Install VSD on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
   1. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Separate line, load, and control conductors in separate continuous metallic conduits. Provide ferrous metallic shielding around each VSD conductor group when conductors are installed in wire way or gutter. The contractor may submit shielded conductor cable assemblies designed for operation with VSD's.

E. Provide all power connection including wiring associated with any isolation transformer disconnect reactors, filters, and any accessories. Include power wiring from the VSD to the motor, as well as all grounding connections.

F. Where it is not possible to install motors within the sight of the VSD provide a disconnect switch at the motor as required by the NEC or required by the specifications. Provide an interlocking connection between the disconnect at the motor and the VSD to prevent the VSD from operating in a no load situation.

G. All connections to the VSD shall be with a minimum 18 inches of seal tight flexible conduit, allowing for ease of maintenance.

H. Provide separate grounding conductor to the VSD and between the VSD and the motor in addition to the conduit system.

I. Temperature control contractor shall provide all control connections to the VSD from any sensors or control devices.

J. Provide separate overload protection for each motor when a VSD serve multiple motors.

K. Install fuses in each fusible-switch VSD.

L. Install fuses in control circuits if not factory installed.

M. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
N. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

O. Comply with NECA 1.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VSDs and remote devices and facility’s central-control system.
B. Bundle, train, and support wiring in enclosures.
C. Connect selector switches and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.5 IDENTIFICATION

A. Identify VSDs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VSD with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.
B. Operating Instructions: Frame printed operating instructions for VSDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VSD units.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Manufacturer’s Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
C. Perform tests and inspections with the assistance of a factory-authorized service representative.
D. Tests and Inspections:
   1. Inspect VSD, wiring, components, connections, and equipment installation
   2. Test insulation resistance for each VSD element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at VSD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
   5. Test each motor for proper phase rotation.
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
E. VSDs will be considered defective if they do not pass tests and inspections.
F. Prepare test and inspection reports, including a certified report that identifies the VSD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. At a minimum perform the following operational checks and provide a report to the engineer that each VSD has met the following checks:
      a. Maximum output frequency = 60 Hz ± 1 Hz.
      b. Minimum output frequency = 4 Hz ± 1 Hz.
      c. Control signal setpoint ± 10% of that specified.
      d. Simulated power outage and control system reaction.
      e. Manual bypass switchover and operation tested.
      f. Starting into an already rotating motor load and determine if self-protection of the VSD is adequate.
      g. Acceleration rate from a dead stop to full speed at the maximum and minimum rate adjustment.
      h. Deceleration rate from full speed to dead stop at maximum and minimum rate adjustment.

3.8 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges.

F. Set field-adjustable pressure switches.

3.9 PROTECTION

A. Replace VSDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VSDs.

END OF SECTION
SECTION 230516
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Expansion joints
   2. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS
A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
   2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
   3. Alignment Guide Details: Detail field assembly and attachment to building structure.
   4. Schedule: Indicate type, manufacturer’s number, size, material, pressure rating, end connections, and location for each expansion joint.

1.5 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of expansion joint, from manufacturer.

1.6 CLOSEOUT SUBMITTALS
A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.7 QUALITY ASSURANCE
A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. ASME Boiler and Pressure Vessel Code: Section IX.
PART 2 - PRODUCTS

2.1 EXPANSION JOINTS


1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flex-Hose Co., Inc.
   b. Flexicraft Industries.
   c. Flex-Weld, Inc.
   d. Garlock Sealing Technologies.
   e. General Rubber Corp.
   g. Metraflex, Inc.
   h. MG Piping Products Co.
   i. Proco Products, Inc.
   j. Red Valve Company, Inc.
   k. Senior Flexonics, Inc.; Pathway Division.
   l. Tozen America Corp.
   m. Unaflex Inc.
   n. Vibration Mountings & Controls, Inc.

2. Arch Type: Multiple arches.

3. Spherical Type: Multiple spheres.
   a. Minimum Pressure and Temperature Ratings for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
   b. Minimum Pressure and Temperature Ratings for NPS 5 and NPS 6: 140 psig at 200 deg F.
   c. Minimum Pressure and Temperature Ratings for NPS 8 to NPS 12: 140 psig at 180 deg F.

4. Material: EPDM.


B. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flex-Hose Co., Inc.
   b. Flexicraft Industries.
   c. Flex-Pression, Ltd.
   d. Metraflex, Inc.

2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder-joint end connections.
   a. NPS 2N 50) and Smaller: Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
   b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.

3. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged end connections for NPS 2-1/2 and larger.
   a. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
   b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
c. NPS 8 to NPS 12: Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg FkPa at 21 deg C) and 90 psig at 600 deg F ratings.

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Steel guides shall be welded to the pipe at a maximum spacing of 90°. The outside diameter of the opposing guide bars shall be smaller than the inside diameter of the pipe riser clamp in accordance with standard field construction practice. Each end of the pipe guide shall be rigidly attached to an omnidirectional pipe anchor isolation mounting which in turn, shall be rigidly fastened to the steel framing within the shaft. See Detail on Drawings.

B. The omnidirectional pipe anchor isolation mountings shall consist of a telescoping arrangement of two sizes of steel tubing separated by a minimum of 12mm (1/2”) thick heavy duty neoprene and canvas duct isolation pad. Vertical restraints shall be provided by similar material arranged to prevent vertical travel in either direction. The allowable load on the isolation material shall not exceed 500 psi.

C. Low temperature piping guides shall be constructed with a 360° 10-gauge metal sleeve around the piping. The thermal insulation requirements for the piping shall be provided between the piping and the sleeve. Heavy duty neoprene and canvas duct isolation pad of thickness equal to thermal insulation requirements shall space the metal sleeve away from the piping with urethane or other suitable thermal insulation provided in the voids between the pipe-sleeve and isolation pan material. The metal sleeve outside diameter shall be smaller than the pipe riser clamp inside diameter in accordance with standard field construction practice. The pipe riser clamp shall be rigidly attached to the steel framing within the shaft.

D. Alignment Guides:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Adsco Manufacturing LLC. (www.adscomfg.com)
   b. Advanced Thermal Systems, Incorporated (www.advancedthermal.net)
   c. Flex-Hose Company Incorporated (www.flexhose.com)
   d. Flex-Weld, Inc. (www.flex-weld.com)
   e. Flexicraft Industries. (www.flexicraft.com)
   f. Hyspan Precision Products, Incorporated (www.hyspan.com)
   g. Mason Industries, Incorporated (www.mason-ind.com)
   h. Metraflex Company (The). (www.metraflex.com)
   i. Senior Flexonics Pathway. (www.sfpathway.com)
   j. U.S. Bellows, Incorporated (www.usbellows.com)
   k. Unisource Manufacturing, Inc. (www.unisource-mfg.com)

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

E. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, with tension and shear capacities appropriate for application.
5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened Portland cement concrete, with tension and shear capacities appropriate for application.
a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION
A. Install expansion joints of sizes matching sizes of piping in which they are installed.
B. Install grooved-joint expansion joints to grooved-end steel piping
C. Install manufactured, nonmetallic expansion joints according to FSA’s “Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors.”
D. Install expansion joints, in serviceable locations, of sizes matching size of piping in which they are installed.
E. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION
A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION
A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
C. Attach guides to pipe and secure guides to building structure.
D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
E. Anchor Attachments:
   2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
   1. Anchor Attachment to Steel Structural Members: Attach by welding.
   2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer’s written instructions.
G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION
SECTION 230517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions
      and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Sleeves.
      2. Stack-sleeve fittings.
      3. Sleeve-seal systems.
      4. Sleeve-seal fittings.
      5. Grout.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.1 SLEEVES
   A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel
      collar; zinc coated.
   B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated,
      with plain ends.
   C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded
      longitudinal joint.

2.2 STACK-SLEEVE FITTINGS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group. (www.zurn.com)
      3. Josam Company
   B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring,
      bolts, and nuts for membrane flashing.
      1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Advance Products & Systems, Incorporated (www.apsonline.com)
      2. CALPICO, Incorporated (www.calpicoinc.com)
      4. Pipeline Seal and Insulator, Incorporated (www.pipelineseal.com)
5. Proco Products, Incorporated (www.procoproducts.com)

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

### 2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Presealed Systems. (ps.holdrite.com)
   2. GPT Industries
   3. The Metraflex Company

B. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping OD.

### 2.5 GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

### PART 3 EXECUTION

#### 3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 “Joint Sealants.”

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping outlined in other specification sections.

F. Install sleeves for pipes passing through Noise critical spaces:
   1. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). These spaces are the Theater, all spaces within the theater footprint (grids AF.3 to AC.2 and A1 to A6), Studios, Classrooms, Meeting Rooms, Green Room, and the Scene Shop.
   2. Penetrations by ducts, pipes and conduit between noise critical spaces shall be sleeved, packed and sealed airtight with non-hardening sealant as described herein. Refer also to other requirements in plans and specifications. Where information is duplicated, in conflict, complementary, etc. the more stringent acoustic requirements shall apply.

3.2 STACK-SLEEVE-FITTING INSTALLATION
A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.
   3. Install section of cast-iron soil pipe to extend sleeve to 4 inches above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION
A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION
A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.
C. Secure nailing flanges to concrete forms.
D. Using grout, seal the space around outside of sleeve-seal fittings.
3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Walls above Grade:

2. Exterior Concrete Walls below Grade:
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

5. Slabs above Grade:
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

6. Slabs above Grade in Mechanical Rooms, Equipment Rooms, Housekeeping Rooms, Catering Rooms, Janitor Rooms and Any Space Adjacent or Above to Galleries or Room Containing Collections:
   a. Piping Smaller Than NPS 6: Stack sleeves.
   b. Piping NPS 6 and Larger: Stack sleeves.

END OF SECTION
SECTION 220518
ESCUTCHEONS FOR HVAC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions
      and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Escutcheons.
      2. Floor plates.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.0 ESCUTCHEONS
   A. One-Piece, Cast-Brass Type: With finish to match adjacent surface and setscrew fastener.
   B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with finish to match adjacent sur-
      face and spring-clip fasteners.
   C. One-Piece, Stamped-Steel Type: With finish to match adjacent surface and spring-clip fasteners.
   D. Split-Casting Brass Type: With polished, chrome-plated and finish to match adjacent surface with
      concealed hinge and setscrew.
   E. One-Piece, Paintable Type: one-piece, low-profile paintable escutcheon plate.

2.1 FLOOR PLATES
   A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
   B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 EXECUTION

3.1 INSTALLATION
   A. Install escutcheons for exposed piping penetrations of walls, ceilings, and finished floors.
   B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that
      completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass, split-casting brass type with finish to match adjacent surface, or one-piece paintable.
      c. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass, split-casting brass type with finish to match adjacent surface, or one-piece paintable.
d. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
e. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
f. Exterior Piping at Building Penetration: One-piece, cast-brass, split-casting brass type with finish to match adjacent surface, or one-piece paintable.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION
SECTION 230519
METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Liquid-in-glass thermometers.
   2. Light-activated thermometers.
   3. Thermowells.
   4. Dial-type pressure gages.
   5. Gage attachments.
   6. Test plugs.
   7. Test-plug kits.
   8. Flowmeters.
B. Related Sections:
   1. Division 23 Section “Steam and Condensate Heating Piping” for steam meters.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS
A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flo Fab Incorporated
      b. Miljoco Corporation.
      d. Tel-Tru Manufacturing Company.
      e. Trerice, H. O. Company
      f. Weiss Instruments, Incorporated
      g. Winters Instruments - U.S.
   3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
   4. Case Form: Adjustable angle unless otherwise indicated.
   5. Tube: Glass with magnifying lens and blue [or red] organic liquid.
   6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in degrees F.
   7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
   b. Design for Thermowell Installation: Bare stem.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 LIGHT-ACTIVATED THERMOMETERS

A. Direct-Mounted, Light-Activated Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flo Fab Incorporated
      b. REOTEMP Instrument Corporation.
      c. Trerice, H. O. Company
      d. Weiss Instruments, Incorporated
      e. WIKA Instrument Corporation - USA.
      f. Winters Instruments - U.S.
   2. Case: Plastic; 7-inch nominal size unless otherwise indicated.
   3. Scale(s): Degrees F and degrees C.
   6. Stem: Aluminum and of length to suit installation.
      b. Design for Thermowell Installation: Bare stem.
   8. Accuracy: Plus or minus 1 degrees F.

2.3 THERMOWEELS

A. Thermowells:
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   3. Material for Use with Copper Tubing: CNR or CUNI.
   4. Material for Use with Steel Piping: CRES or CSA.
   5. Type: Stepped shank unless straight or tapered shank is indicated.
   6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
   7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
   8. Bore: Diameter required to match thermometer bulb or stem.
   9. Insertion Length: Length required to match thermometer bulb or stem.
   10. Lagging Extension: Include on thermowells for insulated piping and tubing.
   11. Bushings: For converting size of thermowell’s internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMETEK, Incorporated; U.S. Gauge.
      b. Ashcroft Incorporated
      c. Ernst Flow Industries.
d. Flo Fab Incorporated

e. Marsh Bellofram.

g. Noshok.

h. Palmer Wahl Instrumentation Group.

i. REOTEMP Instrument Corporation.

j. Tel-Tru Manufacturing Company.

k. Trerice, H. O. Company

l. Watts Regulator Company; a Division of Watts Water Technologies, Incorporated

m. Weiss Instruments, Incorporated

n. WIKA Instrument Corporation - USA.

o. Winters Instruments - U.S.


3. Case: Sealed type; cast aluminum; 4-1/2-inch nominal diameter.

4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

6. Movement: Mechanical, with link to pressure element and connection to pointer.

7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.


11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.

C. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

D. Provide with coil syphons and gauge valves on hot pressure media such as steam systems.

2.6 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flow Design, Incorporated


3. National Meter, Incorporated

4. Peterson Equipment Company, Incorporated

5. Sisco Manufacturing Company, Incorporated

6. Trerice, H. O. Company

7. Watts Regulator Company; a Division of Watts Water Technologies, Incorporated

8. Weiss Instruments, Incorporated

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 275 degrees F.

F. Core Inserts: EPDM self-sealing rubber.
2.7 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flow Design, Incorporated
   2. Miljoco Corporation
   3. National Meter, Incorporated
   4. Peterson Equipment Company, Incorporated
   5. Sisco Manufacturing Company, Incorporated
   6. Trerice, H. O. Company
   7. Watts Regulator Company; a Division of Watts Water Technologies, Incorporated
   8. Weiss Instruments, Incorporated

B. Furnish two test-plug kits containing **one** thermometers, one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 degrees F and 104 degrees C.

D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.

E. Carrying Case: Metal or plastic, with formed instrument padding.

2.8 FLOWMETERS

A. Turbine Flowmeters

1. Manufacturers: Subject to compliance with requirements, provide control system component products by one of the listed manufacturers:
   a. Onicon Incorporated.

2. Insertion turbine flow meters made for insertion in hydronic piping fluid flow that measures flow in gallons per minute (GPM).
   a. Pipe sizes 2-inches and smaller: single turbine.
   b. Pipe sizes 2-1/2-inches and larger: Dual turbine.

3. Output: Flow meters will provide an analog electronic output signal compatible with the building automation system.

4. Sensing Method: Impedance sensing; non-magnetic and non-photoelectric.

5. Accuracy: 2 percent of flow rate from 0.4 to 20 feet per second.

6. Materials:
   b. Housing 316 stainless steel.
   c. Shaft: Tungsten carbide.
   d. Wetted Parts: Bronze and carbon steel.
   e. External Parts: Bronze and carbon steel.

B. Electromagnetic Flowmeters

1. Manufacturers: Subject to compliance with requirements, provide control system component products by one of the listed manufacturers:
   a. Onicon Incorporated.

2. In-line body electromagnetic flow meters made for use in hydronic piping fluid flow that measures flow in gallons per minute (GPM). Flow meter shall have no moving parts and shall have inherent bi-direction flow measurement.

3. Output: Flow meters will provide an analog electronic output signal compatible with the building automation system.

4. Accuracy:
   a. Velocities between 3.3 and 33 fps: within 0.2 percent of reading.
b. Velocities between 1.0 and 3.3 fps: within 0.75 percent of reading.
c. Velocities less than 1.0 fps: within 0.0075 fps.

5. Materials:
   a. Flow meter shall have no moving parts
   b. Body: Epoxy-coated carbon steel
   c. Body: 316 stainless steel
   d. Body: Type 316 stainless steel.
   e. Body Liner: PTFE
   f. Flow Tube: Type 304 stainless steel.
   g. Electrode: Type 316 stainless steel
   h. Electronics enclosure: Removable NEMA 250, Type 6.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.
D. Fill thermowells with heat-transfer medium.
E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
G. Install valve and snubber in piping for each pressure gage for fluids (except steam).
H. Install valve and syphon fitting in piping for each pressure gage for steam.
I. Install test plugs in piping tees.
J. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer’s written instructions.
K. Install flowmeter elements in accessible positions in piping systems.
L. Install wafer-orifice flowmeter elements between pipe flanges.
M. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer’s written instructions.
N. Install permanent indicators on walls or brackets in accessible and readable positions.
O. Install connection fittings in accessible locations for attachment to portable indicators.
P. Install thermometers in the following locations:
   1. Inlet and outlet of each hydronic coil in air-handling units.
   2. Inlet and outlet of each boiler and thermal-storage tank.
Q. Install pressure gages in the following locations:
   1. Discharge of each pressure-reducing valve.
   2. Inlet and outlet of each chiller chilled-water connection.
   3. Suction and discharge of each pump. Refer to piping detail.
3.2 CONNECTIONS
A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
B. Connect flowmeter-system elements to meters.
C. Connect flowmeter transmitters to meters.

3.3 ADJUSTING
A. After installation, calibrate meters according to manufacturer's written instructions.
B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE
A. Thermometers at inlets and outlets of building entrance piping (chilled water and steam):
   1. Direct-mounted, light-activated type.
B. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
   1. Direct-mounted, light-activated type.
C. Thermometers at inlet and outlet of each boiler shall be one of the following:
   1. Direct-mounted, light-activated type.
D. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:
   1. Direct-mounted, light-activated type.
   2. Test plug with EPDM self-sealing rubber inserts.
E. Thermometers at inlet and outlet of each thermal-storage tank shall be the following:
   1. Direct-mounted, light-activated type.
F. Upstream and downstream of main system mixing valves.
G. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE
A. Scale Range for Chilled-Water Piping: 0 to plus 100 degrees.
B. Scale Range for Heating, Hot-Water Piping: 0 to 200 degrees F.

3.6 PRESSURE-GAGE SCHEDULE
A. At a minimum, provide at these locations:
   1. Suction and discharge of each pump.
   2. Upstream and downstream of each pressure regulating device.
   3. Upstream and downstream of filters, separators and pump strainers.
   4. Upstream and downstream of hot water heaters/boilers.
   5. Upstream and downstream of each coil, or coil bank, in air handling units.
   6. Pressurized tanks/receivers.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE
A. Scale Range for Chilled-Water Piping: 0 to 100 psi.
B. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.
3.8 PRESSURE/TEMPERATURE TEST STATIONS
A. At a minimum, install upstream and downstream of:
   1. At each individual coil in air handling units with multiple coils.
   2. Each terminal coil.
   3. Each heat exchanger/converter.

3.9 FLOWMETER SCHEDULE
A. Flowmeters for Chilled-Water Piping: Impeller-Turbine.
   1. Where installed in locations where manufacturer's installation recommendations and requirements are not met, electromagnetic flow meters shall be used.
   1. Where installed in locations where manufacturer’s installation recommendations and requirements are not met, electromagnetic flow meters shall be used.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions
      and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes the following general-duty valves:
      1. Copper-alloy ball valves.
      2. Ferrous-alloy butterfly valves.
      4. Steel spring check valves.
      5. Cast iron spring check valves.
      7. Chainwheel actuators.
   B. Related Sections include the following:
      1. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
      2. Division 23 piping Sections for specialty valves applicable to those Sections only.
      3. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and charts.
      4. Division 23 Section "Hydronic Piping" for calibrated balancing valves.
      5. Division 23 Section "Instrumentation and Control for HVAC" for control valves and actuators.

1.3 DEFINITIONS
   A. The following are standard abbreviations for valves:
      1. CWP: Cold working pressure.
      2. EPDM: Ethylene-propylene-diene terpolymer rubber.
      3. PTFE: Polytetrafluoroethylene plastic.
      4. SWP: Steam working pressure.
      5. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS
   A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve
      design; pressure and temperature classifications; end connections; arrangement; dimensions; and
      required clearances. Include list indicating valve and its application. Include rated capacities;
      shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE
   A. ASME Compliance: ASME B31.1 for power piping valves and ASME B31.9 for building services
      piping valves.
   B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design
      criteria.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.
B. Bronze Valves: NPS 3 and smaller with threaded ends, unless otherwise indicated.
C. Ferrous Valves: NPS 4 and larger with flanged ends, unless otherwise indicated.
D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
F. Valve Actuators:
   1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
   2. Handwheel: For valves other than quarter-turn types.
   3. Lever Handle: For quarter-turn valves NPS 6 and smaller.
G. Extended Valve Stems: Valves in Insulated Piping: Valves shall have 2 inch stem extensions and the following features:
   1. Ball Valves: Shall have 2-1/4 inch extended stem and memory stops that are fully adjustable after insulation is applied.
   2. Butterfly Valves: Shall have extended necks.
H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves; and ASME B16.24 for bronze valves.
I. Threaded: With threads according to ASME B1.20.1.
J. Valve Bypass and Drain Connections: MSS SP-45.
2.3 COPPER-ALLOY BALL VALVES

A. Manufacturers:
   1. Two-Piece, Copper-Alloy Ball Valves:
      a. American Valve
      b. Conbraco Industries, Incorporated; Apollo Division
      c. Hammond Valve.
      d. Jamesbury, Incorporated
      e. Milwaukee Valve Company.
      f. NIBCO Incorporated

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves sizes ¼ to 3-inches: Bronze body with standard-port and threaded ends, stainless steel ball; PTFE or TFE seats; and 600-psig minimum CWP rating; 150-psig saturated steam and extended blowout-proof stem. 2-1/4-inch extended stem. Example: Conbraco #70-140 Series

D. Cast Iron Ball Valve size 4 inches and larger: Cast iron body with standard-port and flanged ends, Teflon fused solid iron ball; RPTFE seats; 125 psig minimum CWP rating; blowout-proof stainless steel stem. Example: American Valve model 4000

2.4 FERROUS-ALLOY BUTTERFLY VALVES

A. Manufacturers:
   1. Tapped Lug, Ferrous-Alloy Butterfly Valves:
      b. Velan Valve Corporation
      c. University approved equal

B. Tapped Lug Butterfly Valves: 4 Inches and Larger: 200 psi CWP (12 Inches and Smaller), 250 degrees F. continuous service, Ductile iron body and bonnet, 316 stainless steel shaft and disc, stainless-steel stem, field-replaceable EPDM sleeve and stem seals, extended neck, drilled and tapped lug end connections, "bubble-tight" shutoff at rated pressure. Body to have 2" extended neck for insulation. Lug style valves shall be capable of providing bi-directional “Dead End Service” at full pressure without the need for down stream blind flange. Not for steam service. Example: Tyco Vanessa 30,000 series.

2.5 BRONZE CHECK VALVES 2 INCHES AND SMALLER

A. Manufacturers:
   1. Bronze, Silent Spring Check Valves with Nonmetallic Disc:
      a. Milwaukee Valve Company.
      b. NIBCO Incorporated
      c. University approved equal

B. Bronze Check Valves, General: MSS SP-80.

C. Class 250, 300 lb WOG, Bronze, Spring Check Valves: Bronze body with nonmetallic disc and bronze seat. Example Milwaukee 510T.

2.6 STEEL SPRING CHECK VALVES

A. Manufacturers:
   1. Steel Spring Check Valves with Composition to Metal Seats:
      a. DFT Inc.
B. Steel Spring Valves, General: MSS SP-71.
   1. ANSI Class 150, carbon steel, spring-assisted non-slam check valves with soft seats and flanged ends. Example DFT GLC.

2.7 CAST IRON SPRING CHECK VALVES
A. Manufacturers:
   1. Cast Iron Spring Check Valves with Composition to Metal Seats
      a. Milwaukee.
B. Cast Iron Spring Check Valves, General: MSS SP-25.
   1. ANSI Class 125, cast iron, non-slam spring check valves with stainless steel springs and flanged ends. Example: Milwaukee 1800.

2.8 BRONZE GLOBE VALVES – WATER SERVICE
A. Manufacturers:
   1. Bronze Globe Valves with Nonmetallic Disc:
      a. Cincinnati Valve Company
      b. Crane Company; Crane Valve Group.
      c. Hammond Valve.
      d. Milwaukee Valve Company.
      e. NIBCO Incorporated
      f. Powell, Wm. Company
      g. Walworth Company
B. Bronze Globe Valves, General: MSS SP-80, with ferrous-alloy handwheel.
C. Class 150, Bronze Globe Valves: Bronze body with PTFE or TFE disc and union-ring bonnet.
   1. Example: NIBCO #T-235-Y or #S-235-Y

2.9 CHAINWHEEL ACTUATORS
A. Manufacturers:
   1. Babbitt Steam Specialty Company
   2. Roto Hammer Industries, Incorporated
B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
   2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   3. Chain: Hot-dip, galvanized steel of size required to fit sprocket rim.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.
B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service:
   a. Water and water solutions:
      1) NPS 3 and smaller: Ball valves.
      2) NPS 4 and larger: butterfly valves.

2. Throttling Service:
   a. Water and water solutions:
      1) NPS 3 and smaller: Ball Valves.
      2) NPS 4 and larger: globe or butterfly valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Chilled-Water Piping: Use the following types of valves:

   1. Ball Valves, NPS 3 and Smaller: Two piece, 600-psig CWP rating, copper alloy.
   2. Butterfly Valves, NPS 4 and Larger: Tapped Lug, 150-psig CWP rating, ferrous alloy, with EPDM liner.

D. Heating Water Piping: Use the following types of valves:

   1. Ball Valves, NPS 3 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
   3. Spring Check Valves, NPS 2 and Smaller: Type 4, bronze
   4. Spring Check Valves, NPS 2.5 and Larger, ANSI Class 125 cast iron.

E. Select valves with the following end connections:

   1. For Copper Tubing, NPS 3 and Smaller: Threaded ends.
   2. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   3. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or welded ends.
   4. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install chainwheels on operators for valves NPS 4 and larger and more than 144 inches above floor except in shop areas. Extend chains to 12 inches above ceiling plane / lighting plane.
G. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

3.4 JOINT CONSTRUCTION
   A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.

3.5 ADJUSTING
   A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

   END OF SECTION
SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Equipment supports.

B. Related Sections:
   1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
   2. Section 230548 "Noise and Vibration Controls for HVAC" for vibration isolation devices.
   3. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS
A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

B. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.
1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

C. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
      b. Cooper B-Line, Inc. (www.cooperindustries.com)
      c. Flex-Strut Inc. (www.flexstrut.com)
      d. Thomas & Betts Corporation. (www.tnb.com)
      e. Unistrut Corporation; Tyco International, Ltd. (www.unistrut.com)
      f. Wesanco, Inc. (www.wesan co.com)
   2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   4. Channels: Continuous slotted steel channel with in-turned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   1. Carpenter & Paterson, Inc. (www.carpenterandpaterson.com)
   3. ERICO International Corporation. (www.erico.com)
   5. PHS Industries, Inc. (www.phsind.com)
   7. Piping Technology & Products, Inc. (www.pipingtech.com)

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:
   1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. Base: [Plastic] [Stainless steel].
   3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.


I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
   5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
   6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.
3.3 METAL FABRICATIONS
A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING
A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING
A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting"; Section 099123 "Interior Painting" and Section 099600 "High Performance Coatings."
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE
A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
B. Comply with MSS SP-69 and ANSI/MSS SP-58-2009 for pipe-hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
H. Use padded hangers for piping that is subject to scratching.
I. Use thermal-hanger shield inserts for insulated piping and tubing.
J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Direct attachment to the composite roof deck in any exposed ceiling room is not allowed. Hang ducts, piping, and equipment from the joists. Provide separate sub-structure if required to span between joists as needed for hanger spacing.
2. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
3. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
4. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
5. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
6. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
7. C-Clamps (MSS Type 23): For structural shapes.
8. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
9. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
10. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
11. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
12. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
13. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
14. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
15. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
16. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Comply with MSS SP-69 and ANSI/MSS SP-58-2009 for pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
Q. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Isolation of vibrations induced by HVAC Systems from spaces for which Noise Criteria have been established in Division 1, including vibration isolators, equipment bases, and flexible connections.

1.2 SUMMARY
   A. Mount rotating and reciprocating mechanical equipment, ductwork, and piping on vibration isolators as noted in the Contract Documents. Select, install and adjust isolators to prevent the transmission of objectionable vibration and noise to the building structure.

1.3 RELATED WORK
   A. Perform vibration isolation work in this Contract, including work described in other Divisions, to meet the product and execution requirements of this Section. Related work includes:
      1. Division 1 – General Requirements
      2. Division 3 – Concrete
      3. Division 4 – Masonry
      4. Division 5 – Metals
      5. Division 14 – Conveying Equipment
      6. Division 22 – Plumbing
      7. Division 23 – Heating, Ventilating and Air Condition
      8. Division 26 – Electrical
      9. Division 1 – General Acoustic Requirements
      10. Section 079219 – Acoustical Sealants
      11. Section 220548 – Noise and Vibration Control for Plumbing Systems
      12. Section 260548 – Noise and Vibration Control for Electrical Systems

1.4 QUALITY ASSURANCE
   A. Provide all vibration isolators and equipment bases for Division 22, 23 and 26 work from the product line of a single manufacturer, unless otherwise accepted by the Acoustics Consultant.
   B. Select isolators to provide uniform deflections within acceptable tolerances when supporting the equipment approved for this project. Coordinate as required with the equipment manufacturers to accomplish this.
   C. Provide engineering, isolator selection, site supervision, and inspection by manufacturer's personnel who shall perform these services directly. Alert the Engineer and Acoustics Consultant of isolator selections that may result in resonances with the equipment and structural systems they are intended to isolate. Replace isolators that upon installation are found to resonate with the supported equipment.
   D. Provide complete isolation systems that include all elements recommended by the manufacturer for compliance with project requirements and applicable codes, ordinances, and regulations. Include all incidental products and materials required for a complete installation even if not explicitly described in the Construction Documents.
   E. Installation & Verification:
1. Install vibration isolation systems using skilled workers trained and licensed, as applicable, by the manufacturer for installations of the types used on this project.

2. Upon completion of the Work, provide final inspection by the manufacturer's representative and submit to the Architect and Engineer a written report authored by the manufacturer's representative certifying the correctness of installation and compliance with the approved submittal data. Include tabulation of the static deflection expected under design and operating loads in comparison with the actual static deflection measured in the completed installations.

1.5 STANDARDS

1.6 ENGINEERING
A. The Construction Documents are indicative of isolation requirements. Provide complete engineering services for all components of isolation systems used in this project.

1.7 SUBMITTALS
A. Submit manufacturer's data, shop drawings, and product performance certifications in accordance with Division 1.

B. Manufacturer's Data: Submit technical product data confirming that products comply with specified requirements:
   1. Illustrations and descriptions of components including, but not limited to isolators, equipment bases, anchors, and accessories.
   2. Operation and maintenance instructions.

C. Shop Drawings
   1. Details of isolation systems, including plan and section drawings indicating isolator and flexible connection locations and types, isolator and connector schedules, details for resilient penetrations, and installation details.
   2. Isolator location drawings will be based on contractor's shop drawings rather than engineer's drawings whenever possible. If shop drawings are not used, the contractor will be required to make field-modifications, including but not limited to replacement and/or relocation of isolators, based on final field conditions at no cost to the owner.
   3. Indicate substrate construction required of other subcontractors.
   4. An initial submittal "For Type Only" is acceptable to confirm the scope of the isolators on the project if the necessary shop drawings by others (i.e. ductwork or equipment) are not yet available to provide final isolator sizing at the time of the initial submission. In this case a follow-up submittal will be required indicating precise isolator sizing and location as noted elsewhere in this section.

D. Samples: provide a sample of each type of isolator assembly used in the project. It is not necessary to submit samples of each spring capacity and pad hardness.

E. Supervision plan for manufacturer's representative in the field during installation of vibration isolation systems.

F. General Requirements for Vibration Isolation Mounts and Hangers: Provide catalog cut sheets, shop drawings, and other documents as necessary to describe the installation and its components. Include the following information:
   1. Calculations:
a. Submit manufacturer's engineer's calculations of loads, deflections, and natural frequencies for record only.

2. Color code legend for spring and elastomer capacities.

3. Certifications:
   a. Certify that elastomeric pads meet the requirements of AASHTO Highway Bridge Specification.

4. Springs Summary, for each spring-based isolator:
   a. Equipment name and number
   b. Operating Weight of Equipment
   c. Lowest reciprocating or rotating speed
   d. Isolator type
   e. Weight supported by isolator
   f. Scheduled deflection
   g. Proposed deflection under operating load
   h. Natural Frequency
   i. Spring free height
   j. Spring operating height
   k. Spring solid height at coil bind
   l. Spring diameter

5. Elastomeric Pads, for each elastomer-based isolator:
   a. Equipment name and number
   b. Operating Weight of Equipment
   c. Isolator type
   d. Weight supported by isolator
   e. Pad bearing area
   f. Pad free height
   g. Pad operating height
   h. Scheduled deflection
   i. Proposed deflection under operating load
   j. Percent deflection
   k. Natural Frequency
   l. Hardness and compliance with AASHTO Bridge Bearing Neoprene quality standard

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers listed below have demonstrated an ability to comply with specifications for vibration isolation products similar to those required for this project. However, specific products made by the listed manufacturers do not all comply with the requirements of this specification. Subject to the requirement for a single manufacturer and the restrictions regarding unacceptable types of isolators, the products of the following manufacturers are acceptable sources for this project:

1. Mason Industries, Inc. (Mason), Hauppauge, New York
2. Kinetics Noise Control (Kinetics), Dublin, Ohio
3. Vibration Mountings and Control Group (VMC Group), Houston, Texas
4. CDM Novitec (CDM), Evanston, IL
5. Thybar Corporation (Thybar), Addison, IL
6. E.A.R., Indianapolis (EAR), Indiana
7. PSI-Thunderline/Link-Seal (PSI-Thunderline), Houston, Texas
8. Ductmate Industries, Inc. (Ductmate), East Monongahela, PA
9. DynAir Inc. (DynAir), Lachine, QB
10. Carlisle Hardcast (Carlisle), Wylie, TX

2.2 SPRING REQUIREMENTS
A. Provide steel springs with static deflections equal to or greater than those shown on the Construction Documents. Submittals based on rated deflections will be rejected.
B. Size springs to provide not less than 50 percent additional travel to solid, coil-bind condition beyond the deflection under operating load.
C. Size springs so that diameter is not less than 80 percent of the height of the spring at operating load.
D. Provide springs that do not permanently deflect after loading to a solid, coil-bind condition.
E. Do not weld springs to other components of the isolator assembly unless specifically noted in the Submittals and accepted by the Acoustics Consultant.
F. Color code springs to allow positive identification after installation. Match color coding to the color code legend provided with the submittals.

2.3 ELASTOMER REQUIREMENTS
A. Provide elastomeric elements with static deflections equal to or greater than those shown on the Construction Documents. Submittals based on rated deflections will be rejected.
B. Provide neoprene elements with a maximum hardness of 40 durometer, Shore A rating, where possible, but in no case exceeding 50 durometer. Where deflections called out in the construction documents exceed those required to achieve the specified natural frequencies, the greater deflection will govern.
C. Meet AASHTO Highway Bridge Specifications for all neoprene products installed in irretrievable locations and as required elsewhere in the Construction Documents.

2.4 CORROSION RESISTANCE
A. Treat isolators and associated hardware for resistance to corrosion to the following requirements:
   1. Interior exposure:
      a. Steel isolator components: PVC coating or phosphate treatment with finish coat of industrial grade enamel paint.
      b. Structural steel bases and associated components: Cleaned of welding slag, primed with zinc chromate primer (steel) or metal etching primer (aluminum); industrial grade enamel finish coat.
      c. Nuts, bolts, and other fasteners: zinc electroplate with etching primer and enamel paint finish coat.
   2. Exterior exposure:
      a. Steel components: PVC coating; or hot-dipped or electroplated zinc with neoprene or bitumastic finish coat.
      b. Aluminum components: etched and painted with industrial grade enamel paint.
      c. Nuts, bolts, and other fasteners: zinc electroplate with etching primer and enamel paint finish coat.

2.5 ACCEPTABLE PRODUCTS
A. Equipment Bases & Rails
   1. Type B-1 Bases – Steel Bases
a. Provide rigid steel frames that will not twist, deform, deflect, or crack in any manner that would affect the operation of the isolated equipment or the performance of the isolators. Size steel bases to support equipment housings, motors, and associated pipe and duct elbows, electrical control elements, and any other related components requiring resilient support because of its location on the equipment side of the flexible connections to distribution ductwork and piping. Supply steel frame under this specifications section.

b. Provide bases with minimum depth of 6 inches. Increase depth as required to achieve required rigidity with a minimum depth of one tenth of the longest dimension of the base. Space isolators not more than ten times the steel depth apart. Provide a minimum of 2 inches clearance between floor or housekeeping pad and underside of steel base. Use height-saving brackets if required to maintain equipment clearances.

c. Acceptable products:
   1) Mason WF
   2) Kinetics SFB or SBB
   3) VMC Group WFB

2. Type B-2 Bases – Steel Rails
   a. Provide structural steel sections sized to prevent deflection and distortion that would affect operation of equipment and performance of isolators. Include end-mounting brackets for attachment of isolators.

b. Provide a minimum of 2 inches clearance between underside of rail and floor or housekeeping slab. Provide not less than 12 inches from underside of rails to roof deck.

3. Type B-3 Bases – Concrete Inertia Bases
   a. Provide inertia bases of normal weight concrete (150 pcf) and appropriate steel reinforcing within perimeter frames of steel channel, in a rigid assembly that will not twist, deform, deflect, or crack in any manner that would affect the operation of the isolated equipment or the performance of the isolators. Size inertia bases to support equipment housings, motors, and associated pipe and duct elbows, electrical control elements, and any other related components requiring resilient support because of its location on the equipment side of the flexible connections to distribution ductwork and piping. Supply steel frame under this specifications section. Provide concrete under this section or Division 3.

b. Provide bases with minimum thickness of 6 inches. Increase thickness as required to achieve required mass according to the Isolation Schedule within this specification. Size perimeter steel to be not less than one twelfth of the longest dimension of the base. Space isolators not more than ten times the slab thickness apart. Provide a minimum of 2 inches clearance between floor or housekeeping pad and underside of slab. Use height-saving brackets if required to maintain equipment clearances.

c. Acceptable products:
   1) Mason types K and BMK
   2) Kinetics Type CIB
   3) VMC Group CPF

B. Equipment Curbs
   1. Type C-1 Curbs – Low Deflection Spring Isolation Curbs
      a. Provide vibration isolation bases for curb-mounted rooftop equipment. Provide laterally-stable springs as otherwise specified in paragraph 2.2 and bearing on ¼ inch neoprene pads. Provide resilient snubbers not less than ¼ inch thick to limit lateral deflection under wind loads.

b. Flashing required to shed water may not affect the performance of the isolation system under any combination of design loads. Use flexible EPDM membrane for closure between isolation base and fixed curb.

c. Acceptable products:
   1) Mason CMAB
2) Kinetics ESR
3) Thybar Vibro-Curb III

2. Type C-2 Curbs – High Deflection Spring Isolation Curbs
   a. Provide vibration isolation bases for curb-mounted rooftop equipment. Provide laterally-
      stable springs as otherwise specified in paragraph 2.2 and bearing on ¼ inch neoprene
      pads. Provide resilient snubbers not less than ¼ inch thick to limit lateral deflection under
      wind loads.
   b. Flashing required to shed water may not affect the performance of the isolation system
      under any combination of design loads. Use flexible EPDM membrane for closure between
      isolation base and fixed curb.
   c. When lower curb is used as a plenum, provide not less than 2 inches of fiberglass
      insulation on outboard face of fixed curb, and ensure that flexible flashings and other
      components of the plenum are airtight without rigid contact between the upper and lower
      curbs.
   d. Acceptable products:
      1) Mason RSC
      2) Kinetics ESR
      3) Thybar Vibro-Curb III

C. Floor-Supported Mounts
   1. Type M-1 Mounts – Neoprene Pads
      a. 3/4”-inch minimum thickness, waffled or ribbed neoprene.
      b. Where multiple layers are required to provide the specified deflections, interleave pads with
         16 gauge steel shim plates. Size pads for deflection equal to 10 to 15 percent of unloaded
         height and provide pads of sufficient thickness to achieve the specified deflection. Provide
         load-distributing top plates if required for uniform loading.
      c. Acceptable products for individual pads:
         1) Mason W, SW, and Super W
         2) Kinetics RSP
         3) VMC Group NRC Pads
      d. Acceptable products for neoprene/steel composite pads:
         1) Mason WSW
         2) Kinetics RSP with steel shim
         3) VMC Group NRC Flex Plates
   2. Type M-2 Mounts – Neoprene-in-Shear Mounts
      a. Provide double-deflection in-shear isolators with steel bottom plates with pre-drilled bolt
         holes for attachment to floor or base, a threaded steel insert at the top of the isolator for
         attaching the equipment, and friction surfaces at both top and bottom. Coat all metal
         surfaces with neoprene.
      b. Acceptable products:
         1) Mason ND
         2) Kinetics RD
         3) VMC Group RVD
   3. Type M-3 Mounts – Open Springs
      a. Provide isolators of the general characteristics described in paragraph 2.2, above, that are
         freestanding and laterally stable with no housing and that are furnished with level-
         adjustment bolts for rigid connection to the isolated equipment. Provide with molded
         neoprene cup or 1/4 inch thick elastomeric friction pad between isolator baseplate and its
         support. Vary spring size as required for equal deflection under non-uniformly distributed
         equipment loads.
      b. Acceptable products:
         1) Mason SLF
2) Kinetics FDS
3) VMC Group AC

4. Type M-4 Mounts – Restrained Open Springs
   a. Provide built-in adjustable spring restraints for equipment with operating weight greater than weight upon installation to prevent equipment from deflecting (or rising) when the additional weight is applied (or removed in the future). Provide isolators as specified for Type M-4 but with restraint studs and adjustable nuts. Provide ½ inch minimum clearance around the restraint studs. Use bridge-bearing quality neoprene for elastomeric friction pads at chillers and cooling towers.
   b. Acceptable products:
      1) Mason SLR
      2) Kinetics FLS
      3) VMC Group M

D. Ceiling-Supported Hangers
1. Type H-1 Hangers – Not Used
2. Type H-2 Hangers – Neoprene-in-Shear Hangers
   a. Provide neoprene-in-shear element mounted in a rigid steel hanger box. Mold neoprene element with a rod isolation bushing that prevents rigid contact between hanger rod and housing from vertical through an angular deflection of not less than 30 degrees in any direction.
   b. For ductwork hung by straps, provide hangers with eyes on the top and bottom to allow for bolting to the straps.
   c. Acceptable products:
      1) Mason HD and WHD
      2) Kinetics RH
      3) VMC Group RH
3. Type H-3 Hangers – Open Spring with Elastomer
   a. Provide neoprene-in-shear element of 1¼-inch minimum thickness and a spring of the general characteristics specified in Paragraph 2.2, above. Seat spring in a molded neoprene cup with steel washer reinforcing. Mold neoprene element with a rod isolation bushing that prevents rigid contact between hanger rod and housing from vertical through an angular deflection of not less than 15 degrees in any direction. Do not directly stack the spring and neoprene isolator elements.
   b. For ductwork hung by straps, provide hangers with eyes on the top and bottom to allow for bolting to the straps.
   c. Acceptable products:
      1) Mason 30N
      2) Kinetics SRH
      3) VMC Group HSRA
4. Type H-4 Hangers – Pre-Compressed Open Spring with Elastomer
   a. Provide built-in adjustable spring restraints for equipment with operating weight greater than weight upon installation to prevent equipment from deflecting (or rising) when the additional weight is applied (or removed in the future). Provide isolators similar to Type H-3, but pre-compressed with restraint mechanisms that can be released to free the spring when subjected to its operational load. Provide an integral scale to indicate amount of deflection.
   b. For ductwork hung by straps, provide hangers with eyes on the top and bottom to allow for bolting to the straps.
   c. Acceptable products:
      1) Mason PC30N
      2) Kinetics SRH, with restraints
3) VMC Group HRSRA

E. Wall-Supported Equipment Mounts
   1. Type W-1 Mount – Captive Neoprene
      a. Maximum 50 durometer solid neoprene or neoprene housed in steel casing. Provide threaded insert to receive equipment mounting bolt.
      b. Acceptable products:
         1) Mason BR, RBA, or RCA
         2) Kinetics RQ
         3) VMC Group MB, RSM

F. Pipe Riser Supports & Guides
   1. Type P-1 Support – Neoprene Pipe Support
      a. All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch (13-mm-) thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.
      b. Acceptable products:
         1) Mason ADA
         2) Kinetics KPA
         3) VMC Group LD
   2. Type P-2 Support – Neoprene Pipe Guide
      a. Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch (13-mm-) thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and re-insertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.
      b. Acceptable products:
         1) Mason VSG
         2) Kinetics KPG
         3) VMC Group AG

G. Flexible Connections
   1. Type FC-1 Connector – Neoprene Twin-Sphere Piping Connectors
      a. Provide flanged twin-sphere or threaded single-sphere isolators with Kevlar cord and peroxide-cured EPDM body with steel rings embedded in flanges to prevent pull-out. Connectors must accept elongation, compression, axial, and transverse motion. Select materials to suit system temperature, pressure, and fluid type. Do not use control rods or cables to limit extension of the isolator.
      b. Acceptable products:
         1) Twin-sphere connectors:
            (a) Mason types SFDEJ, SFDCR
            (b) Kinetics Type FTC
            (c) VMC Group 2600
         2) Single-sphere connectors (only acceptable for pipe sizes where twin-sphere connectors are not available, see Schedule):
            (a) Mason types SFEJ, SFU
            (b) Kinetics Type FC
            (c) VMC Group 2800
   2. Type FC-2 Connector – Flexible Braided Stainless Steel Hose
      a. Provide carbon steel flanges for pipes greater than 3 inches diameter. Male nipples are acceptable for pipe diameters smaller than 3 inches.
b. Acceptable products:
   1) Mason FFL and MN
   2) Kinetics Kinflex BFMC
   3) VMC Group SS

3. Type FC-3 Connector – Flexible Duct Connection to Equipment
   a. Provide Hypalon-coated, woven fiberglass, flameproof fabric (24 oz per square yard), serviceable from -40°F to 250°F.
   b. Acceptable products:
      1) Ductmate Pro-Flex
      2) Dyn-Air Connector-Plus
      3) Carlisle Hardcast Hypalon

4. Type FC-4 Connector – Below-Grade Penetration Seals
   a. Modular EPDM, nitrile, or silicone seal, as appropriate for specific field conditions, with accompanying sleeves, caps, and accessories. Provide fire- and high-temperature rated components where required by project conditions and applicable codes.
   b. Acceptable products:
      1) PSI-Thunderline, Link-Seal

H. Resilient Wrap for Small-Diameter Pipe and Conduit
1. Type SD-1 Wrap – Closed Cell Rubber Foam
   a. Provide minimum 3/4-inch thick closed cell rubber or neoprene wrap in sheets to be cut to size, or in pre-molded form to slip over the pipe/conduit without gaps.
      1) Armacell Armafix or Armaflex
      2) K-Flex Isul-Lock DS
      3) Aeroflex Aerofix or Aerocell
   b. Where closed cell rubber foam insulation is provided for thermal purposes, this insulation may serve as SD-1 wrap without provision of additional wrap for acoustic purposes.

I. Isolation Accessories
1. Elastomeric Isolators for Mounting Bolts
   a. Provide neoprene grommets, bushings, and washers for all bolts used to secure isolators to floors and housekeeping slabs and for all snubbers. Size bolt holes and washers to accommodate grommets, sleeves, and bushings and to preclude contact between rigid components that would cause bridging between isolated elements and the building structure. Baseplates for neoprene pads may be rigidly bolted to the floor or housekeeping slab if the bolts secure the baseplates only and do not continue through the neoprene to meet any other rigid material. Do not exceed 40 durometer, Shore A hardness.
   b. Acceptable products include:
      1) Mason HG, HLB and HLW
      2) E.A.R. Isodamp and C-1000
      3) VMC Group RB

2. Thrust Restraints & Sway Braces
   a. Provide spring isolators with the same characteristics and deflection as the isolator springs. Preset thrust restraint isolators in the factory and fine tune in the field to allow for a maximum of 1/4-inch deflection between at-rest and maximum-thrust conditions. Furnish with appropriate brackets to attach to equipment and the structure. Install restraints on centerline of thrust and symmetrically on both sides of the equipment.
   b. Acceptable products include:
      1) Mason WB
      2) Kinetics HSR
      3) VMC Group TRK
PART 3 EXECUTION

3.1 GENERAL

A. Before commencing installation examine the substrate and surrounding conditions to ensure that there is nothing to prevent proper and timely execution of the installation. Beginning work specified in this Section indicates acceptance of the substrate and surrounding conditions.

B. Install isolation systems in strict compliance with manufacturer’s recommendations and engineering, and submittal data. Make no rigid connections to structure that would compromise the performance of the isolation systems.

C. Resiliently mount or hang mechanical equipment, ductwork, piping, and other equipment on structural components indicated on the Drawings and as specified in this section.

D. For all isolated equipment, make connections of piping, ductwork, and conduit using flexible connections specified in this section. Make no connections to isolated equipment in a manner that would compromise the performance of the isolation systems. Refer to Section 230548 – Noise and Vibration Control for Electrical Systems for requirements related to isolation of electrical equipment and connections.

E. Establish isolator locations for ease of installation, adjustment, and inspection as well as specified performance.

F. Replace isolators found to resonate with building structure, at no additional cost to the Owner.

3.2 GENERAL REQUIREMENTS FOR MOUNTS AND HANGERS

A. Align mounts and hangers squarely above or below the equipment mounting holes to avoid introducing lateral loads and deflection.

B. Deflection requirements:
   1. Verify installed isolators have deflections equal to or greater than deflections specified on the submittals.
   2. Where multiple deflections apply to a single isolator (where a single isolator supports multiple isolated elements), the largest deflection governs.
   3. Vary the size and/or hardness of isolators as required to yield equal deflection for all isolators supporting a single piece of equipment or length of pipe or ductwork. Consult manufacturer for direction when specified isolators do not yield required deflection and correct non-compliant isolators at no cost to the Owner.

C. Support equipment, ductwork, conduit and piping independently. Do not hang equipment, ductwork, piping, or conduit from other isolated equipment, ductwork, piping, or conduit.

D. Maintain 2 inches of clearance between isolated elements and walls, ceilings, and other non-isolated building components.

E. Isolate drain piping attached to vibration isolated equipment from rigid components of the building.

F. Limit stops must be inactive and out of contact with the isolator during equipment operation.

G. Adjust leveling bolts and hanger rod lengths so that equipment is level and in alignment with connecting ductwork and piping.

H. Restrained isolators may be substituted for unrestrained isolators at installer’s option to simplify installation.
I. Isolate hanger rods passing through barrier ceilings with elastomeric sleeves or grommets or treat as resilient penetrations in accordance with the details and Section 079219 – Acoustical Sealants. Unless noted otherwise, locate equipment, piping, and ductwork below barrier ceilings.

### 3.3 EQUIPMENT MOUNTED ON FLOORS, HOUSEKEEPING PADS, AND STRUCTURAL ELEMENTS

A. For equipment with bases, locate isolators on the sides of the base that are parallel to the equipment shaft.

B. At housekeeping slabs and pedestals, position isolators with entire bearing plate on slab or pedestal. Do not cantilever baseplates beyond edges of slabs and pedestals. Coordinate isolator locations with housekeeping slabs so that outboard height-saving mounts do not contact the housekeeping slabs. Notify contractor of work by others requiring remediation for proper installation of isolators.

C. For floor-mounted equipment, provide a minimum of 2 inches operating clearance from the lowest point of the base to the floor or housekeeping slab. Verify that 2 inches of unobstructed clearance has been provided in the final installation under operating loads. Correct nonconforming conditions at no cost to the Owner. Provide height-saving brackets as required to maintain required equipment clearances.

D. For concrete inertia bases, set steel perimeter on bond breaker material, provide steel reinforcing in compliance with Manufacturer's recommendations, and pour normal weight concrete to the full depth of the perimeter steel. If no reinforcing is specified, provide ½-inch reinforcing bar at 6-inch centers each way, and weld reinforcing to the perimeter steel 1½ inches above the bottom of the steel. Provide required anchor bolts held in position by steel templates during the pour.

### 3.4 ISOLATION SCHEDULE – EQUIPMENT

A. Provide isolation mounts and hangers for equipment as follows (see also notes after table). Static deflections indicated in the table below are minimum values.

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>On Grade Installation</th>
<th>Above Grade Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
<td>Isolator</td>
</tr>
<tr>
<td>Air Handling Units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,000cfm or greater</td>
<td>B-1</td>
<td>M-3</td>
</tr>
<tr>
<td>Less than 4,000cfm</td>
<td>B-1</td>
<td>M-1</td>
</tr>
<tr>
<td>Roof-Mounted Air Handling Units, Packaged Rooftop Units, and Mushroom-Type Fans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,000cfm or greater</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Less than 4,000cfm</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Fans, Fan Coil Units, and Heat Pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,000cfm or greater</td>
<td>B-1</td>
<td>M-3</td>
</tr>
<tr>
<td>Less than 4,000cfm</td>
<td>B-1</td>
<td>M-1</td>
</tr>
<tr>
<td>Equipment Type</td>
<td>On Grade Installation</td>
<td>Above Grade Installation</td>
</tr>
<tr>
<td>----------------------------------------------------</td>
<td>-----------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td></td>
<td>Base</td>
<td>Isolator</td>
</tr>
<tr>
<td>Condensing Units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motors (if motor base is separate from associated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>equipment)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5HP or greater</td>
<td>B-1</td>
<td>M-2</td>
</tr>
<tr>
<td>Less than 5HP</td>
<td>B-1</td>
<td>M-1</td>
</tr>
<tr>
<td>Chillers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reciprocating or Screw</td>
<td>B-1</td>
<td>M-4</td>
</tr>
<tr>
<td>Boilers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Tube</td>
<td>B-1</td>
<td>M-2</td>
</tr>
<tr>
<td>Fire Tube</td>
<td>B-1</td>
<td>M-3</td>
</tr>
<tr>
<td>Base-Mounted Pumps &amp; Compressors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5HP or greater</td>
<td>B-3</td>
<td>M-3</td>
</tr>
<tr>
<td>Less than 5HP</td>
<td>--</td>
<td>M-2</td>
</tr>
<tr>
<td>Inline Pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5HP or greater</td>
<td>B-3</td>
<td>M-3</td>
</tr>
<tr>
<td>Less than 5HP</td>
<td>--</td>
<td>M-2</td>
</tr>
<tr>
<td>Passive devices connected to rotating equipment (</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expansion Tanks, Heat Exchangers, Deaerators, etc.)</td>
<td>--</td>
<td>M-1</td>
</tr>
</tbody>
</table>

1. Schedule Notes:
   a. The static deflection listed in the Schedule is a minimum acceptable value for installed deflection. Manufacturers may need to submit isolators with a higher “nominal” deflection in order to achieve the deflection listed above.
   b. For equipment specified with B-1 bases, it is acceptable to install the isolators directly under the equipment without the use of the base if the equipment is able to be supported by point loads. This must be confirmed by the equipment manufacturer.
   c. Where inertia bases (type B-3) are indicated, they will be sized as follows:

<table>
<thead>
<tr>
<th>Motor Size</th>
<th>Minimum Thickness of Inertia Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 to 20 horsepower</td>
<td>6 inches</td>
</tr>
<tr>
<td>25 to 50 horsepower</td>
<td>8 inches</td>
</tr>
<tr>
<td>60 to 100 horsepower</td>
<td>10 inches</td>
</tr>
</tbody>
</table>
d. For air handling units or packaged rooftop units with internal isolation approved by the isolator manufacturer’s engineer, provide Type M-1 neoprene isolators between the unit or base and the floor, housekeeping slab, or curb. If the isolator manufacturer’s engineer cannot approve the internal isolation, the internal isolators must be locked down with shipping bolts and not used.

e. Fan-powered box isolation schedule assumes internally isolated neoprene mounting of fan. If no fan isolation is provided, additional isolation will be required (follow requirements for fan coil units).

f. Quick reference for isolator types:
   1) Base B-1: Steel frame
   2) Base B-2: Steel rails
   3) Base B-3: Concrete inertia base
   4) Curb C-1: Low-deflection spring isolation curb
   5) Curb C-2: High-deflection spring isolation curb
   6) Mount M-1: Neoprene pad
   7) Mount M-2: Neoprene-in-shear
   8) Mount M-3: Open spring
   9) Mount M-4: Restrained open spring
  10) Mount M-5: Pneumatic isolator
  11) Hanger H-1: Not used
  12) Hanger H-2: Neoprene-in-shear
  13) Hanger H-3: Open spring
  14) Hanger H-4: Pre-compressed open spring

3.5 ISOLATION SCHEDULE – DUCTWORK, PIPING, AND CONDUIT

A. Provide isolation mounts and hangers for ductwork, piping, and conduit:

<table>
<thead>
<tr>
<th>Device</th>
<th>Within 30ft. of Reciprocating Equipment or Within the Entirety of the Equipment Room (Whichever is Greater)</th>
<th>Within 8ft. of Crossing an Acoustic Isolation Joint or Acoustically-Isolated Construction; When Hung from the Underside of a Room with a Noise Criteria RC 20 or less</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flr/Clg</td>
<td>Wall</td>
</tr>
<tr>
<td>Ductwork</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater than 1” diameter</td>
<td>M-3/ H-3</td>
<td>H-3</td>
</tr>
<tr>
<td>1” diameter or less</td>
<td>SD-1</td>
<td>W-1/ SD-1</td>
</tr>
<tr>
<td>In Vertical Shaft (&gt;1” dia.)</td>
<td>P-1/P-2</td>
<td>--</td>
</tr>
</tbody>
</table>

1. Schedule Notes:
   a. The distance away from equipment (or crossing an AIJ/AIC) is measured along the run of the ductwork, piping, or conduit.
b. Multiple ducts/pipe/conduit may be installed on the same trapeze hanger, with isolators supporting the trapeze. In the case of such ganged installations, the highest-deflection isolator should be used for the trapeze isolators.

c. Where wall support indicates an “H-#” type isolator, this requires that the duct/pipe/conduit be hung of a bracket that is wall mounted, with isolators within the length of a threaded rod supporting it.

d. Where piping is provided with jacketed fiberglass insulation wrap, this insulation can fulfill the requirements of SD-1 wrap without provision of additional wrap for acoustic purposes.

e. All isolation for ductwork, piping and conduit includes elements such as:
   1) VAV boxes, dampers, reheat coils and other duct-mounted elements.
   2) Pipe valves
   3) Electrical pull boxes and junction boxes

f. Piping connected to fan coil units, fan-powered boxes, and reheat coils does not require isolation mounts for 30ft beyond the equipment (see requirements for flexible connectors below).

2. Position isolators as high as possible in the hanger rod or strap assembly but not in direct contact with the building structure without manufacturer’s written authorization. Provide 1 inch minimum clearance between isolator housing and structure above. Provide side clearance for hangers to allow full 360-degree rotation about the rod axis without contacting any object.

3. Drain pipes for air handling units shall be supported only from the isolated air handling unit frame. The condensate shall drip into a funnel that is supported from the floor or floor drain. A gap of at least 2 inches shall be maintained between the end of the air handling unit drain pipe and funnel or floor drain.

### 3.6 ISOLATION SCHEDULE – FLEXIBLE CONNECTIONS

A. Provide flexible connections for all ductwork, piping, and conduit as follows:

<table>
<thead>
<tr>
<th>Device</th>
<th>Size</th>
<th>Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ductwork</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connections to all fans and equipment with integral fans</td>
<td>All</td>
<td>FC-3</td>
</tr>
<tr>
<td>Where ductwork crosses an AIU or AIC with rigidly-mounted fire or fire/smoke dampers within the wall</td>
<td>All</td>
<td>FC-3 (both sides of the damper)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Piping Connected to Reciprocating Equipment</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumps (except as noted below), Chillers, Condensing Units, Boilers, Air Handling Units</td>
<td>&lt; 2” diameter</td>
<td>FC-1 (single-sphere)</td>
</tr>
<tr>
<td></td>
<td>2” to 14” diameter</td>
<td>FC-1</td>
</tr>
<tr>
<td></td>
<td>&gt;14” diameter</td>
<td>FC-1 (single sphere)</td>
</tr>
<tr>
<td>Fan Coil Units, Fan-Powered Boxes</td>
<td>All</td>
<td>FC-2</td>
</tr>
<tr>
<td>Air Compressor Pumps</td>
<td>All</td>
<td>FC-2</td>
</tr>
<tr>
<td>Sewage Ejector Pumps</td>
<td>All</td>
<td>Flexible coupling per pump supplier</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Piping Connected to Passive Equipment</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Exchangers, Expansion Tanks, Glycol Tanks, Dearators, Reheat Coils</td>
<td>&lt; 2” diameter</td>
<td>FC-1 (single sphere)</td>
</tr>
<tr>
<td></td>
<td>2” to 14” diameter</td>
<td>FC-1</td>
</tr>
</tbody>
</table>
1. FC-3 flexible duct connections are to be configured as follows:
   a. Crimp fabric into duct flanges and seal airtight.
   b. Provide minimum separation of 6 inches between duct and equipment.
   c. Provide 1½ inch minimum slack or as required to accommodate full range of equipment and duct movement when subjected to maximum operating and lateral loads simultaneously without becoming taut.
   d. Utilize thrust restraints as required to limit horizontal movement so that flexible connections do not become taut under any combination of operational loads.
   e. Mount flexible duct connections as close to equipment housings as practical but in no case beyond the first duct hanger.

3.7 ISOLATION SCHEDULE – ACCESSORIES
A. Provide isolation accessories for all isolated HVAC equipment as follows:
   1. All bolted connections between equipment and non-isolated structure, or at other locations recommended by the isolation manufacturer, must be made using Elastomeric Isolators for Mounting Bolts.

3.8 TESTING, EVALUATION, AND ACCEPTANCE PROCEDURES
A. Upon completion of the installation, the vibration isolation manufacturer will send a representative to the site to inspect and approve the installation. The manufacturer’s field report must certify that all of the isolators have been installed in accordance with the manufacturer’s instructions and will include the type and measured static deflection of all spring isolators.
B. If it is found that the construction fails the acoustic test measurements or performance requirements identified in the Contract Documents, make changes necessary to meet the requirements identified in the Contract Documents and be responsible for the costs associated with performing all additional acoustical tests to verify the acoustic performance of the construction. Costs for additional acoustical testing shall include consulting fees at per hour rates in effect at the time of testing along with related expenses including, but not limited to, travel expenses and test equipment use charges.

END OF SECTION
SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct labels.
   5. Valve tags.
   6. Warning tags.

1.3 ACTION SUBMITTALS
A. Pipe, Ductwork, Equipment and Valve identification schedule for review and confirmation with Engineer and owner.
B. Ceiling tag identification for review and confirmation with Architect and owner.
C. Product Data: For each type of product indicated.
D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION
A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.
D. Coordinate ceiling tag identification with owner and architect before installation.

PART 2 PRODUCTS

2.0 EQUIPMENT LABELS
A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: Blue.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
Identification for HVAC Piping and Equipment

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
1. Review and confirm labels with owner prior to marking and installation.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.1 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions. Review and confirm warning signs and labels with owner prior to marking and installation.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Review and confirm pipe labels with owner prior to marking and installation.
2. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
3. Lettering Size: At least 1-1/2 inches high.
2.3 VALVE TAGS
A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.
B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Review and confirm valve schedules with owner prior to marking and installation.
   2. Valve-tag schedule shall be included in operation and maintenance data.

2.4 DUCT LABELS
A. General Requirements for Manufactured duct Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
B. Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing.
C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
   1. Review and confirm duct labels with owner prior to marking and installation.
   2. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
   3. Lettering Size: At least 1-1/2 inches high.

2.5 WARNING TAGS
A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 EXECUTION
3.1 PREPARATION
A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.
3.2 EQUIPMENT LABEL INSTALLATION
A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.
C. Provide operational data including manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.
D. Identify all equipment with engraved laminated plastic with white lettering and black background. Lettering/numbering will be no less than ¾” in height. Nameplates exposed to sunlight will be made of UV resistant material.

3.3 PIPE LABEL INSTALLATION
A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
B. Pipe Label Color Schedule:
   1. Chilled-Water Piping:
      a. Background Color: Blue.
      b. Letter Color: White
   2. Make-up Water Piping:
      a. Background Color: Green
      b. Letter Color: White
   3. Heating Water Piping:
      a. Background Color: Red.
   4. Condensate Piping:
      a. Background Color: Blue.

3.4 DUCT LABEL INSTALLATION
A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
   1. Blue: For cold-air supply ducts.
   2. Red: For hot-air supply ducts.
   4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 30 feet in each space where ducts are exposed or concealed by removable ceiling system.
3.5 **VALVE-TAG INSTALLATION**

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. **Valve-Tag Size and Shape:**

2. **Valve-Tag Color:**
   b. Hot Water: Natural.

3. **Letter Color:**
   b. Hot Water: Black.

3.6 **WARNING-TAG INSTALLATION**

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 **CEILING-TAG INSTALLATION**

A. For equipment (VAV boxes, fans, fan coil units, equipment, filters, etc.) and branch isolation valves located above suspended ceilings, label ceiling grid (not the tile) at key access points with a clear adhesive label with bold black lettering (font size 16) with equipment, etc., ID information.

**END OF SECTION**
SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.
   2. Balancing Hydronic Piping Systems:
      a. Constant-flow hydronic systems.
      b. Variable-flow hydronic systems.
      c. Primary-secondary hydronic systems.
   3. HVAC equipment quantitative-performance settings.
   4. Exhaust hood airflow balancing.
   5. Space pressurization testing and adjusting.
   6. Verifying that automatic control devices are functioning properly.
   7. Existing systems TAB.
   8. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS
A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
B. Balance: To proportion flows within the distribution system, including sub mains, branches, and terminals, according to indicated quantities.
C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person’s skin than is normally dissipated.
E. NC: Noise criteria.
F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
G. RC: Room criteria.
H. Report Forms: Test data sheets for recording test data in logical order.
I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.


S. TAB: Testing, adjusting, and balancing.


U. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS


C. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

D. Sample Report Forms: Submit two sets of sample TAB report forms.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by either AABC or NEBB.

1. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.

B. TAB Conference: Meet with Architect and Owners representatives and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:
   b. The TAB plan.
   c. Coordination and cooperation of trades and subcontractors.

C. Coordination of documentation and communication flow. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, "Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

H. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS
A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION
A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY
A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
   1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
   2. Systems are balanced to optimum performance capabilities within design and installation limits.

B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
   1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
   2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and under floor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 "Metal Ducts" division 23 "Nonmetal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units; such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following: 7
   1. Permanent electrical-power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Equipment and duct access doors are securely closed.
   5. Balance, smoke, and fire dampers are open.
   6. Isolating and balancing valves are open and control valves are operational.
   7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   8. Windows and doors can be closed so indicated conditions for system operations can be met.
3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
   1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 "Air Duct Accessories."
   2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 "Duct Insulation," Division 23 "HVAC Equipment Insulation," and Division 23 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
   2. Measure fan static pressures as follows to determine actual static pressure:
      a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
a. Report the cleanliness status of filters and the time static pressures are measured.

4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer’s written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
   a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
   a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record final fan-performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Balance variable-air-volume systems the same as described for constant-volume air systems.
   2. Set terminal units and supply fan at full-airflow condition.
   3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
   4. Readjust fan airflow for final maximum readings.
   5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
   6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
   7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
      a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
   8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
      a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
   2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
   3. Set terminal units at full-airflow condition.
   4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
   5. Adjust terminal units for minimum airflow.
   6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Owner, Commissioning Authority and/or Engineer and comply with requirements in Section 232123 "Hydronic Pumps."
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
   a. Monitor motor performance during procedures and do not operate motors in overload conditions.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated pre-settings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.9 **PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS**

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 **PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS**

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.11 **PROCEDURES FOR MOTORS**

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer's name, model number, and serial number.
   4. Efficiency rating.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.12 **PROCEDURES FOR BOILERS**

A. Measure entering- and leaving-water temperatures and water flow.

3.13 **PROCEDURES FOR HEAT-TRANSFER COILS**

A. Measure, adjust, and record the following data for each water coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:
   1. Nameplate data.
   2. Airflow.
   3. Entering- and leaving-air temperature at full load.
   4. Voltage and amperage input of each phase at full load and at each incremental stage.
   5. Calculated kilowatt at full load.
   6. Fuse or circuit-breaker rating for overload protection.
C. Measure, adjust, and record the following data for each steam coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Airflow.
   3. Air pressure drop.
   4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.

3.14 PROCEDURES FOR TEMPERATURE MEASUREMENTS
A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
C. Measure outside-air, wet- and dry-bulb temperatures.

3.15 PROCEDURES FOR EXHAUST HOODS
A. Measure, adjust, and record the airflow of each exhaust hood. Measure airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, explain why, in the report, and explain the test method used.
B. After balancing is complete, do the following:
   1. Measure and record the static pressure at the hood exhaust-duct connection.
   2. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to achieve optimum results.

3.16 TEMPERATURE-CONTROL VERIFICATION
A. Verify that controllers are calibrated and commissioned.
B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
C. Record controller settings and note variances between set points and actual measurements.
D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
E. Check free travel and proper operation of control devices such as damper and valve operators.
F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
G. Check the interaction of electrically operated switch transducers.
H. Check the interaction of interlock and lockout systems.
I. Check main control supply-air pressure and observe compressor and dryer operations.
J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or non-grounded power supply.
K. Note operation of electric actuators using spring return for proper fail-safe operations.
3.17 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to be reused.
   1. Measure and record the operating speed, airflow, and static pressure of each air terminal device impacted by demolition, relocation and new work.
   2. Measure and record water flow and pressure of each air terminal device on pipe loops impacted by demolition, relocation and new work.
   3. Measure and record water flow and pressure of existing chiller.
   4. Measure and record water flow of each pump impacted by demolition, relocation and new work.
   5. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   6. Check the condition of filters.
   7. Check the condition of coils.
   8. Check the operation of the drain pan and condensate drain trap.
   9. Check bearings and other lubricated parts for proper lubrication.
  10. Report on the operating condition of the equipment and the results of the measurements taken.
      Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.
   1. New filters are installed.
   2. Coils are clean and fins combed.
   3. Drain pans are clean.
   4. Fans are clean.
   5. Bearings and other parts are properly lubricated.
   6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
   1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.
   2. Compare the indicated water flow of impacted work to the measured water flows and balance systems to meet flow rates of existing systems.
   3. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
   4. If calculations increase or decrease the airflow and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated airflow and water flow rates. If 5 percent or less, equipment adjustments are not required.
   5. Air balance each air outlet.

3.18 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
   2. Air Outlets and Inlets: minus 5 to plus 10 percent.
   3. Heating-Water Flow Rate: 0 to minus 10 percent.
   4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.19 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
B. Status Reports: As work progress prepare progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.20 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB contractor.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
       a. Indicated versus final performance.
       b. Notable characteristics of systems.
       c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer's name, type, size, and fittings.
   14. Notes to explain why certain final data in the body of reports vary from indicated values.
   15. Test conditions for fans and pump performance forms including the following:
       a. Settings for outdoor-, return-, and exhaust-air dampers.
       b. Conditions of filters.
       c. Cooling coil, wet- and dry-bulb conditions.
       d. Face and bypass damper settings at coils.
       e. Fan drive settings including settings and percentage of maximum pitch diameter.
       f. Inlet vane settings for variable-air-volume systems.
       g. Settings for supply-air, static-pressure controller.
       h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outdoor, supply, return, and exhaust airflows.
   2. Water and steam flow rates.
   3. Duct, outlet, and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Terminal units.

E. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches (mm), and bore.
   i. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches (mm), and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches w.g.
   e. Filter static-pressure differential in inches w.g.
   f. Preheat coil static-pressure differential in inches w.g.
   g. Cooling coil static-pressure differential in inches w.g.
   h. Heating coil static-pressure differential in inches w.g.
   i. Outside airflow in cfm.
   j. Return airflow in cfm.
   k. Outside-air damper position.
   l. Return-air damper position.
   m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch o.c.
   f. Make and model number.
   g. Face area in sq. ft.
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches w.g.
   d. Outside-air, wet- and dry-bulb temperatures in degrees F.
   e. Return-air, wet- and dry-bulb temperatures in degrees F.
f. Entering-air, wet- and dry-bulb temperatures in degrees F.
g. Leaving-air, wet- and dry-bulb temperatures in degrees F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in degrees F.
k. Leaving-water temperature in degrees F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in degrees F.
o. Inlet steam pressure in psig.

G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:
   a. System identification.
   b. Location.
   c. Coil identification.
   d. Capacity in Btuh.
   e. Number of stages.
   f. Connected volts, phase, and hertz.
   g. Rated amperage.
   h. Airflow rate in cfm.
   i. Face area in sq. ft.
   j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):
   a. Heat output in Btuh.
   b. Airflow rate in cfm.
   c. Air velocity in fpm.
   d. Entering-air temperature in degrees F.
   e. Leaving-air temperature in degrees F.
   f. Voltage at each connection.
   g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.
   f. Arrangement and class.
   g. Sheave make, size in inches, and bore.
   h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches w.g.
   c. Fan rpm.
   d. Discharge static pressure in inches w.g.
e. Suction static pressure in inches w.g.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling unit number.
   b. Location and zone.
   c. Traverse air temperature in degrees F.
   d. Duct static pressure in inches w.g.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Test apparatus used.
   d. Area served.
   e. Air-terminal-device make.
   f. Air-terminal-device number from system diagram.
   g. Air-terminal-device type and model number.
   h. Air-terminal-device size.
   i. Air-terminal-device effective area in sq. ft.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary airflow rate as needed in cfm.
   d. Preliminary velocity as needed in fpm.
   e. Final airflow rate in cfm.
   f. Final velocity in fpm.
   g. Space temperature in degrees F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Entering-water temperature in degrees F.
   c. Leaving-water temperature in degrees F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in degrees F.
   f. Leaving-air temperature in degrees F.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
c. Service.
d. Make and size.
e. Model and serial numbers.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):
   a. Static head in feet of head or psig.
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches (mm).
   d. Full-open flow rate in gpm.
   e. Full-open pressure in feet of head or psig.
   f. Final discharge pressure in feet of head or psig.
   g. Final suction pressure in feet of head or psig.
   h. Final total pressure in feet of head or psig.
   i. Final water flow rate in gpm.
   j. Voltage at each connection.
   k. Amperage for each phase.

M. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.
      d. Dates of use.
      e. Dates of calibration.

3.21 INSPECTIONS

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
   2. Check the following for each system:
      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      d. Verify that balancing devices are marked with final balance position.
      e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:
   1. Final test and balance report requires sign off by Owner.
   2. Architect, Owner, Engineer, or Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 20 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
   3. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as “FAILED.”
4. If the number of “FAILED” measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

5. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.

6. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

E. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

F. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION
SECTION 230700
HVAC INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes mechanical insulation for duct, equipment, and pipe, including the following:
   1. Insulation Materials:
      a. Flexible elastomeric.
      b. Mineral fiber.
      c. Phenolic
      d. Polyisocyanurate.
   2. Lagging
   3. Insulating cements.
   4. Adhesives.
   5. Mastics.
   7. Sealants.
   8. Factory-applied jackets.
   10. Tapes.
   11. Securements.
   12. Corner angles.
B. Related Sections include the following:
   1. Division 7 Section for fire stopping materials and requirements for penetrations through fire and smoke barriers.
   2. Division 23 Section "Metal Ducts" for duct liners.

1.3 DEFINITIONS
A. ASJ: All-service jacket.
B. FSK: Foil, scrim, kraft paper.
C. SSL: Self-sealing lap.
D. Domestic Water: Potable and non-potable.
E. Hydronic Runouts: Hydronic piping less than 2 inches diameter and less than 12 feet in length.
F. Unconditioned Space: An enclosed space within a building that is not a conditioned space or a semiheated space. Crawlspace, attics, and parking garages with natural or mechanical ventilation are not considered enclosed spaces.

1.4 SUBMITTALS
A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).
B. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
   a. Sheet Form Insulation Materials: 12 inches square.
   c. Sheet Jacket Materials: 12 inches square.
   d. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

C. Field quality-control inspection reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

C. Do not apply waterproofing membrane where surface temperature of substrate will exceed 165 degrees F or fall below -10 degrees F.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSULATION MATERIALS

A. Refer to Part 3 schedule articles for requirements about where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Products:
      a. Aeroflex USA Incorporated; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. Nomaco K-Flex
      d. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
   2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches as tested by ASTM E 84.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
   1. Products:
      a. CertainTeed Corporation; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Duct Wrap.
      d. Manson Insulation Incorporated; Alley Wrap.
      e. Owens Corning; All-Service Duct Wrap.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA, or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
   1. Products:
      a. CertainTeed Corporation; Commercial Board.
      b. Fibrex Insulations Incorporated; FBX.
      c. Johns Manville; 800 Series Spin-Glas.
      d. Knauf Insulation; Insulation Board.
      e. Manson Insulation Incorporated; AK Board.
      f. Owens Corning; Fiberglas 700 Series.

I. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products:
- Fibrex Insulations Incorporated; Coreplus 1200.
- Johns Manville; Micro-Lok.
- Knauf Insulation; 1000 Pipe Insulation.
- Manson Insulation Incorporated; Alley-K.
- Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Degrees F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

J. Mineral-Fiber, Pipe, and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type III A Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb./cu. ft. or more. Thermal conductivity (k-value) at 100 degrees F is 0.29 Btu x in./h x sq. ft. x degrees F or less. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:
   - CertainTeed Corporation; CrimpWrap.
   - Johns Manville; MicroFlex.
   - Knauf Insulation; Pipe and Tank Insulation.
   - Manson Insulation Incorporated; AK Flex.
   - Owens Corning; Fiberglas Pipe and Tank Insulation.

K. Polyisocyanurate: Unfaced, preformed, rigid cellular Polyisocyanurate material intended for use as thermal insulation.

1. Products:
   - Apache Products Company; ISO-25.
   - ITW Insulation Systems; Trymer 2000 XP.
   - Duna USA Incorporated; Corafoam.
   - Elliott Company; Elfoam.

   2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.168 Btu x in./h x sq. ft. x Degrees F at 75 degrees F after 180 days of aging.

   3. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches as tested by ASTM E 84.

   4. Flame-spread index shall be 25 or less and smoke-developed index shall be 450 or less for thickness 1-1/2 to 6 inches as tested by ASTM E 84.

   5. Fabricate shapes according to ASTM C 450 and ASTM C 585.


      a. Pipe Applications: ASJ-SSL.
      b. Equipment Applications: ASJ-SSL.

2.3 MASS LOADED VINYL LAGGING

A. Composite limp vinyl sheet consisting of two layers of vinyl over a 1.4 psf barrier layer with a minimum STC rating of 28 and a 1" fiberglass batting decoupler layer.

B. Products

1. Kinetics Noise Control KNM-100ALQ
2. Acoustical Surfaces B-10 QFA-9
3. Barymat BM-1C
4. Engineer Approved Equal

C. Product Characteristics

1. The barrier shall be constructed of a 0.12" thick mass loaded, limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side.
a. Nominal density of barrier: 1.6 psf
b. Minimum STC rating: 30
c. Minimum Flammability rating per Federal Test Standard No. 191-5903:
   1) 0.0 seconds flame-out
   2) 0.2” char length
d. NFPA 90A Flame Spread / Smoke Developed characteristics:
   1) Flame Spread: 10
   2) Smoke Developed: 40
e. Minimum thermal conductivity barrier layer:
   1) K value of 0.29
f. Rated service temperature range
   1) – 40 degrees F to 220 degrees F
2. Decoupler layer
   a. 1” fibrous glass batting
   b. Non woven porous scrim-coated glass cloth
   c. Quilting
      1) 4” diamond stitch to encapsulate glass fibers
3. Seams
   a. 6” overlap tab for field joint sealing
      1) 54” nominal barrier width
      2) 48” nominal decoupler width

2.4 INSULATING CEMENTS
   1. Products:
      a. Insulco, Division of MFS, Incorporated; Triple I.
      c. Or Approved Equal
B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
   1. Products:
      b. Vitcas
      c. Or Approved Equal
C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
   1. Products:
      a. Insulco, Division of MFS, Incorporated; SmoothKote.
      c. Rock Wool Manufacturing Company; Delta One Shot.

2.5 ADHESIVES
A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products:
      a. Aeroflex USA Incorporated; Aeroseal.
      b. Armacell LCC; 520 Adhesive.
      c. Foster Products Corporation, H. B. Fuller Company; 85-75.
      d. RBX Corporation; Rubatex Contact Adhesive.
C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products:
      a. Childers Products, Division of ITW; CP-82.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Incorporated; 225.
      e. Mon-Eco Industries, Incorporated; 22-25.

D. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 degrees F.
   1. Products: Subject to compliance with requirements provide one of the following:
      c. Or Approved Equal

   1. Products:
      a. Childers Products, Division of ITW; CP-82.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Incorporated; 225.
      e. Mon-Eco Industries, Incorporated; 22-25.

F. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products:
      a. Dow Chemical Company (The); 739, Dow Silicone.
      c. P.I.C. Plastics, Incorporated; Welding Adhesive.
      d. Red Devil, Incorporated; Celulon Ultra Clear.
      e. Speedline Corporation; Speedline Vinyl Adhesive.

2.6 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   1. Products:
      a. Childers Products, Division of ITW; CP-35.
      b. Foster Products Corporation, H. B. Fuller Company; 30-90.
      c. ITW TACC, Division of Illinois Tool Works; CB-50.
      d. Marathon Industries, Incorporated; 590.
      e. Mon-Eco Industries, Incorporated; 55-40.
      f. Vimasco Corporation; 749.

   2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perms at 43-mil dry film thickness.
      a. Service Temperature Range: Minus 20 to plus 180 Degrees F.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Products:
2.7 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products:
   a. Childers Products, Division of ITW; CP-10.
   b. Foster Products Corporation, H. B. Fuller Company; 35-00.
   c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
   e. Mon-Eco Industries, Incorporated; 55-50.
   f. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
   (a) Service Temperature Range: Minus 20 to plus 200 degrees F.

3. Solids Content: 63 percent by volume and 73 percent by weight.


2.8 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic-Foam, and Polyisocyanurate Products:
   a. Childers Products, Division of ITW; CP-76.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45.
   c. Marathon Industries, Incorporated; 405.
   d. Mon-Eco Industries, Incorporated; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.
   f. Vimasco Corporation; 750.

2. Joint Sealants for Polystyrene Products:
   a. Childers Products, Division of ITW; CP-70.
   c. Marathon Industries, Incorporated; 405.
   d. Mon-Eco Industries, Incorporated; 44-05.
   e. Vimasco Corporation; 750.

3. Materials shall be compatible with insulation materials, jackets, and substrates.

4. Permanently flexible, elastomeric sealant.

B. Service Temperature Range: Minus 100 to plus 300 degrees F.

1. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

1. Products:
   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
   c. Marathon Industries, Incorporated; 405.
   d. Mon-Eco Industries, Incorporated; 44-05.
2.9 FACTORY-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements provide one of the following:
   a. Johns Manville; Zeston. (www.jm.com)
   c. Proto Corporation; LoSmoke. (www.protocorporation.com)
   d. Speedline Corporation; SmokeSafe. (www.speedlinepvc.com)

2. Adhesive: As recommended by jacket material manufacturer.


4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Products: Subject to compliance with requirements provide one of the following:
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing. (www.itwinsulation.com)
   c. RPR Products, Inc.; Insul-Mate. (www.rphouston.com)

   a. Sheet and roll stock ready for shop or field sizing.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Outdoor Applications
   d. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 0.055 - 0.060 inches thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with aluminum-foil facing.

1. **Products**: Subject to compliance with requirements provide one of the following:
   a. Polyguard Products, Inc.; Alumaguard LT. ([www.polyguardproducts.com](http://www.polyguardproducts.com))
   b. VentureClad

### 2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. **Products**:
   a. Johns Manville; Zeston.
   c. Proto PVC Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. **Adhesive**: As recommended by jacket material manufacturer.

3. **Color**: White

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

### 2.11 TAPES

A. **ASJ Tape**: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.

1. **Products**:
   a. Ideal Tape Company, Incorporated, an American Biltrite Company; 428 AWF ASJ.
   b. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. **Width**: 3 inches.

3. **Thickness**: 11.5 mils.

4. **Adhesion**: 90 ounces force/inch in width.

5. **Elongation**: 2 percent.

6. **Tensile Strength**: 40 lb./inch in width.

7. **ASJ Tape Disks and Squares**: Precut disks or squares of ASJ tape.

B. **FSK Tape**: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136, and UL listed.

1. **Products**:
   a. Ideal Tape Company, Incorporated, an American Biltrite Company; 491 AWF FSK.
   b. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. **Width**: 3 inches.

3. **Thickness**: 6.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   1. Products:
      b. Venture Tape; 1506R.
   2. Width: 1-1/2 inches.
   3. Thickness: 6 mils.
   5. Elongation: 150 percent.
   6. Tensile Strength: 15 lb. /inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL 723 listed.
   1. Products:
      a. Ideal Tape Company, Incorporated, an American Biltrite Company; 488 AWF.
      b. Venture Tape; 3520 CW.
   2. Width: 2.5 inches.
   3. Thickness: 7.3 mils.
   5. Elongation: 5 percent.
   6. Tensile Strength: 34 lbf/inch in width.

2.12 SECUREMENTS
A. Bands (material compatible with jacket):
   1. Products:
      a. Childers Products; Bands.
      b. PABCO Metals Corporation; Bands.
      c. RPR Products, Incorporated; Bands.
   2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.
   3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.

B. Insulation Pins and Hangers:
   1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- or 0.135-inch-diameter shank, and length to suit depth of insulation indicated.
      a. Products:
         1) AGM Industries, Incorporated; CWP-1.
         2) GEMCO; CD.
         3) Midwest Fasteners, Incorporated; CD.
         4) Nelson Stud Welding; TPA, TPC, and TPS.
   2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- or 0.135-inch-diameter shank, and length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
      a. Products:
         1) AGM Industries, Incorporated; CWP-1.
2) GEMCO; Cupped Head Weld Pin.
3) Midwest Fasteners, Incorporated; Cupped Head.
4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products:
      1) AGM Industries, Incorporated; Tactoo Insul-Hangers, Series T.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Incorporated; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low carbon steel, Aluminum, or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products:
      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Incorporated; Nylon Insulation Hangers.
      3) Or Approved Equal²⁰
   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products:
      1) AGM Industries, Incorporated; Tactoo Insul-Hangers, Series TSA.
      2) GEMCO; Press and Peel.
      3) Midwest Fasteners, Incorporated; Self-Stick.
   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low carbon steel, Aluminum, or Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products:
      1) AGM Industries, Incorporated; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Incorporated; WA-150.
      4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Manufacturers:
      1) GEMCO.
      2) Midwest Fasteners, Incorporated
      3) Or Approved Equal

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed, stainless steel or 0.062-inch soft-annealed, galvanized steel.
   1. Manufacturers:
      a. ACS Industries, Incorporated
      b. C & F Wire.
      c. Childers Products.
      d. PABCO Metals Corporation.
      e. RPR Products, Incorporated

2.13 CORNER ANGLES
A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 COMMON INSTALLATION REQUIREMENTS
A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Handholes.

3.4 PENETRATIONS
A. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
   1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Through-Penetration Firestop Systems."
D. Insulation Installation at Floor Penetrations:
   1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Pipe: Install insulation continuously through floor penetrations.
   3. Seal penetrations through fire-rated assemblies according to Division 7 Section "Through-Penetration Firestop Systems."

3.5 DUCT AND PLENUM INSULATION INSTALLATION
A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

3.6 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION
A. Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
   2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   3. Protect exposed corners with secured corner angles.
   4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      a. Do not weld anchor pins to ASME-labeled pressure vessels.
      b. Select insulation hangers and adhesives that are compatible with service temperature and with substrate.
c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
d. Do not over compress insulation during installation.
e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
f. Impale insulation over anchor pins and attach speed washers.
g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch pre-stressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches.

8. Install insulation in removable segments on equipment access doors, manholes, Handholes, and other elements that require frequent removal for service and inspection.


10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

2. Fabricate boxes from stainless steel, at least 0.050 inch thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.7 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyethylene, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

E. Refrigerant Piping
1. All refrigerant piping from the outdoor unit to the indoor units / heat recovery units must be insulated correctly for safety and usage. Y-branch connections, header branch connections, refrigerant piping, field-provided isolation ball valves (if present), service valves, and elbows must be properly and completely insulated using closed cell pipe insulation (up to the indoor unit piping connections). To prevent heat loss / heat gain through the refrigerant piping, all refrigerant piping including liquid lines and vapor lines shall be insulated separately.

2. Wrap insulation around the entire surface of each pipe, including the refrigerant pipes from the indoor unit to the service valves inside the outdoor unit, the branch joints, distribution header, and connection points on each pipe.

3. Do not wrap the vapor and liquid refrigerant pipes together.

4. For pipe connections between the indoor unit and the electronic expansion valve, leave manufacturer's recommended space between vapor and liquid pipe.

5. All insulation joints shall be glued with no air gaps. Insulation material shall fit snugly against the refrigeration pipe with no air space between it and the pipe.

6. Insulation passing through pipe hangers, inside conduit, and/or sleeves must not be compressed.

7. Protect insulation inside hangers and supports with a second layer.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation sections same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation sections same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer’s recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer’s recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not over compress insulation during installation.
      e. Impale insulation over pins and attach speed washers.
      f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 degrees F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not over compress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
5. Install vapor stops for ductwork and plenums operating below 50 degrees F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.10 POLYISOCYANURATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
   2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
   3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation sections same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of Polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of Polyisocyanurate insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.11 MASS LOADED VINYL LAGGING INSTALLATION

A. Cut sound control lagging material to length, wrapped around the outside of the pipe or duct to which the material is to be applied.

B. Fasten with mechanical fasteners or bands

C. Tapes or adhesives for FSK jacketing shall be used in addition to the mechanical fasteners

D. Install per manufacturer design guidelines.

3.12 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.13 FINISHES

A. Exposed: Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.14 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Supply air ductwork:
   1. Concealed or exposed, round or rectangular supply duct from air handling unit discharge up to air terminal unit (VAV box, heating/reheat coil) insulation shall be the following:
      a. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft nominal density, with an overall installed thermal resistance value of not less than R 4.2.
   2. Concealed or exposed, round or rectangular supply duct from air terminal unit (VAV box, heating/reheat coil) to space air discharge shall be insulated when ductwork is not in the space the air terminal unit serves or in the concealed ceiling plenum of the space the air terminal unit serves. Insulation in this condition shall be the following:
      a. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft nominal density, with an overall installed thermal resistance value of not less than R 4.2.
   3. Supply air ductwork shall not be required to be insulated where ductwork is located downstream of the air terminal unit (VAV box, heating/reheat coil) AND is exposed in the space it serves.

B. Return air ductwork:
   1. Not insulated unless noted otherwise on drawings.

C. Outdoor air ductwork:
   1. Concealed or exposed, rectangular or round outdoor-air duct insulation shall be the following:
      a. Mineral-Fiber Board: 2 inches thick and 3.0-lb/cu. ft nominal density for all other outdoor air ductwork.

D. Exhaust air ductwork:
   1. Concealed or exposed, rectangular or round, exhaust-air duct insulation between isolation damper and penetration of building exterior (minimum of 15 feet) shall be the following:
      a. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft nominal density, with an overall installed thermal resistance value of not less than R 6.
2. Dust collector exhaust-air duct insulation between dust collector and penetration of building exterior shall be the following:
   a. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft nominal density, with an overall installed thermal resistance value of not less than R 4.2.

E. Intake or relief louver plenums:
   1. Outdoor air intake plenums or relief air plenums shall be the following:
      a. Mineral-Fiber Board: 2 inches thick and 3.0-lb/cu. ft nominal density for all other outdoor air ductwork.

F. Items Not Insulated:
   1. Metal ducts with duct liner of sufficient thickness to comply with thermal insulation requirements above.
   2. Factory-insulated flexible ducts.
   3. Factory-insulated plenums and casings.
   4. Flexible connectors.
   5. Vibration-control devices.
   6. Factory-insulated access panels and doors.

3.15 EQUIPMENT INSULATION SCHEDULE

A. Insulate the following indoor equipment:
   1. Chilled-water air separators.
   2. Chilled-water pump housings.
   3. Heating hot-water air separators.
   4. Heating hot-water compression tanks.

B. Omit insulation from the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Handholes.

C. Insulation materials and thickness are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

D. Insulate equipment in paragraphs below that is not factory insulated.
   1. Chilled-water pumps insulation shall be the following:
      a. Polyisocyanurate: 1 inch thick.
   2. Chilled-water air-separator and compression tank insulation shall be the following:
      a. Polyisocyanurate: 1 inch thick.
   3. Heating-hot-water air-separator and compression tank insulation shall be the following:
   4. Coil and Fan Housings, and duct silencer insulation:
      a. Mineral-Fiber Board: 1.5 inches thick and 2-lb/cu. ft. nominal density.

3.16 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Flexible connectors.
   2. Vibration-control devices.
3. Heating pipe within radiation enclosures.
4. Heating piping beyond control valve when located within a heated space and within 12 inches of terminal unit.
5. Expansion joints.
6. Cold non-ferrous piping located over a drain pan within unit cabinet.

3.17 PIPING INSULATION SCHEDULE
A. Chilled Water, above 40 Degrees F:
   1. NPS: All sizes
      a. Polyisocyanurate: 1 inch thick.
B. Heating-Hot-Water Supply and Return, 105 to 140 Degrees F:
   1. NPS 1-1/4 and Smaller: Insulation shall be the following:
   2. NPS 1-1/2 and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I, 1.5-inches thick.
C. Refrigerant Piping:
   1. NPS: All Sizes
      a. EPDM of suitable thickness to meet manufacturer’s recommendations and energy code requirements. EPDM must be rated up to 250 deg F operating temperature.

3.18 JACKET SCHEDULE
A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. Ducts and Plenums:
   1. Factory applied FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
C. Piping:
   1. Factory applied ASJ.
   2. Piping in finished spaces located within 8 feet of the floor; less than 200 degrees F: white PVC: 30 mils thick.

3.19 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE
A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. Ductwork, Exposed:
   1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.016 inch minimum
C. Hydronic and Refrigerant Piping, Exposed:
   1. Self-Adhesive Outdoor Jacket
   2. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.016 inch minimum

END OF SECTION
SECTION 230900
INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1. Refer to Division 21, 22, and 23 sections for required control and alarm points.
2. The system will use the BACnet/IP protocol at the TCP/IP level of the architecture.
3. Integrate the new DDC systems into the existing University DDC network. Interface with the digital addressable fire alarm system.
4. Interface with the safety and security system.

B. Related Sections include the following:

1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
2. Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.
3. Division 28 Section "Safety and Security" for requirements that relate to this section.
4. Division 28 Section "Digital Addressable Fire Alarm System" for requirements that relate to this section.

C. Refer to Division-26 Sections for the following work.

1. Power from the power source to the power connection on control panels as indicated on the Electrical Drawings.
2. Interlock wiring between electrically operated equipment units, and between equipment and field-installed control devices as indicated on the Electrical Drawings.
3. The temperature control system shall be on emergency power.

1.3 DEFINITION OF TERMS/ACRONYMS/ABBREVIATIONS

A. In the preparation of submittals and reports use these definitions and abbreviations. Any terms or abbreviations used in submittals and reports that have not been defined in this section will be defined in the first section of the submittal or report prior to their use.

B. The following definitions serve as a guide for industry acronyms in the coming sections:

1. ANSI: American National Standards Institute
2. ASHRAE: American Society of Heating Refrigeration and Air Conditioning Engineers
3. BACnet: Building Automation and Controls Network
4. BAC/IP: BACnet communications protocol via IP
5. BIBBs: BACnet Interoperability Building Blocks
6. BMA: BACnet Manufacturers Association
7. BTL: BACnet Testing Laboratories
8. CSV: Comma Separated Value
9. DDC: Direct Digital Controls
10. EIA: Electronic Industries Association
12. IP: Internet Protocol
14. LAN: Local Area Network
15. LON: Local Operating Network
16. LONTalk: Open, published protocol
17. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
18. MLWS: MultiLiant Workstation software.
19. MS/TP: Master slave/token passing.
20. NIST: National Institute of Standards and Technology
21. OWS: Operator workstation.
22. PC: Personal computer.
23. PICS: Protocol implementation conformance statement
24. PID: Proportional plus integral plus derivative.
25. RTD: Resistance temperature detector.
26. TCP: Transmission Control Protocol
27. UPS: Uninterruptible power supply
28. VAV: Variable air volume
29. WAN: Wide area network

C. Acceptance Date: The date that the installer demonstrates, to the owner or the owner’s representative, that all system components are functioning properly. Refer to demonstration article for demonstration requirements.

1.4 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1. Air Movement and Control Association (AMCA)
2. American National Standards Institute (ANSI)
3. American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
   a. ASHRAE 135-2004 BACnet Standard
4. Federal Communications Commission (FCC)
5. Institute of Electrical and Electronics Engineers (IEEE)
6. International Organization for Standardization (ISO)
7. National Electrical Manufacturers Association (NEMA)
8. National Fire Protection Association (NFPA)

1.5 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:
   1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
   2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
   3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
   4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
   5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
   6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
   7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
   8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
      a. Water Temperature: Plus or minus 1 degrees F.
      b. Water Flow: Plus or minus 5 percent of full scale.
c. Water Pressure:  Plus or minus 2 percent of full scale.
d. Space Temperature:  Plus or minus 1 degrees F.
e. Ducted Air Temperature:  Plus or minus 1 degrees F.
f. Outside Air Temperature:  Plus or minus 2 degrees F.
g. Dew Point Temperature:  Plus or minus 3 degrees F.
h. Temperature Differential:  Plus or minus 0.25 degrees F.
i. Relative Humidity:  Plus or minus 2 percent.
j. Airflow (Pressurized Spaces):  Plus or minus 3 percent of full scale.
k. Airflow (Measuring Stations):  Plus or minus 5 percent of full scale.
l. Airflow (Terminal):  Plus or minus 10 percent of full scale.
m. Air Pressure (Space):  Plus or minus 0.01-inch water gage.
n. Air Pressure (Ducts):  Plus or minus 0.1-inch water gage.
o. Carbon Dioxide:  Plus or minus 50 ppm.
p. Electrical:  Plus or minus 5 percent of reading.

1.6 BUILDING SYSTEMS AUTOMATION NETWORK PERFORMANCE REQUIREMENTS

A. Provide hardware, software, and expertise necessary to tie the BACnet building controller(s) to the University private DDC control network. BACnet integration must conform to Data Link Layer Option BACnet/IP shown in BACnet ANSI/ASHRAE 135-2004 publication Annex J.

B. Install new building level controllers such that BACnet communications on the existing temperature control network are not derogated. Derogation includes router, switch, hub lockups, BACnet building controller lockups, site network excessive slowdowns, unnecessary and repeated ‘who is’ messages. Refer to NIST BACnet standard for definition of unnecessary who-is messages.

C. BACnet read property requests from the University Master BACnet Operator Workstation must not take more than 5 seconds to process once the BACnet Building Controller receives the read request. Object properties that are read requested that require multiple segmented packets must not take more than 5 seconds to process the request. Information that is received from a read property multiple or single read property must not be older that 10 seconds.

1.7 GRAPHIC STANDARDS FOR BUILDING SYSTEMS

A. Graphics will be generated from the vendor’s template library. New graphics will be created at the vendor’s workstation. System graphics will be developed for the vendors DDC system or at the integrated operator’s workstations, not both. Discuss graphic development as part of the installation process. The operator’s workstation (OWS) graphics will follow existing University graphic standards.

1. Hardware points shall have graphic(s) assigned
2. User adjustable software points shall have graphic(s) assigned
3. Create graphic for outside conditions (Outside air, humidity, enthalpy, etc.)
4. The graphics shall note the analog output range and normal position.

B. Each piece of equipment shall have one or more graphics to include the following:

1. Hardware points
2. User adjustable set points
3. Safety alarm points for the system (Fan, pump, static, freeze stat, etc)
4. Heating/cooling switchover points
5. Occupied/unoccupied points
6. Summer/Winter mode points
7. Create graphic(s) for fire systems and other life and safety system alarms (Fire system, refrigerant detection, etc).
8. Create graphic(s) for all other critical points (Elevator, phase outage, generator, etc.).
9. Create separate graphic(s) when more than five identical type of alarm points are monitored
10. Create miscellaneous graphic(s) for other non-critical points (roof drain, sump pump, etc.).
11. Create graphic(s) for building layout and network system configuration with identifying the bus layout.
12. Verify that all programmed points on each graphic are referencing the correct software/hardware point at the controller level.

C. Other graphic criteria:
1. Graphics systems shall use standard templates and colors.
2. Type of font and font sizes shall be identical when appropriate.
3. Text and controller points shall be aligned properly.
4. Points shall flash red when points are in alarm condition.
5. When screens have minimal information, maximize the usage of the screen by enlarging the graphic.
6. Use building equipment numbers when possible for all equipment.
7. Points and descriptors shall not overlap.
8. Meet with the Owner for a minimum of 8 hours to review graphics standards and user interface navigation prior to programming.

1.8 SUBMITTALS
A. Product Data: Include manufacturer’s technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated; and indicate where it will be applied.
   1. Include detailed product data sheets on integration devices.
   2. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
B. Text based documents and product data sheets will be 8 ½ inch by 11 inch format bound on the left edge. Documents will be submitted electronically in portable document format (PDF).
   1. DDC System Hardware
      a. A complete bill of materials of equipment to be used indicating quantity, manufacturer, and model number.
         (a) Manufacturer’s description and technical data for each unique device to include performance curves, product specification sheets, and installation instructions.
         When a manufacturer’s data sheet refers to a series of devices rather than a specific model, the data specifically applicable to the project will be highlighted or clearly indicated by other means.
         (b) This requirement applies to:
            (i) Controllers
            (ii) Transducers/Transmitters
            (iii) Sensors
            (iv) Actuators
            (v) Valves
            (vi) Relays and Switches
            (vii) Control Panels
            (viii) Power Supplies
            (ix) Batteries
            (x) Operator Interface Equipment
      b. An Instrumentation List for each controlled system.
         1) The list will be in a table format.
         2) Include name, type of device, manufacturer, model number, and product data sheet number.
      c. Binding Map
         1) A list of the device-to-device (peer-to-peer) data flow. This will not include the flow of data from devices to the OWS.
         2) Include:
            (a) Description of the variable.
            (b) Sending device.
            (c) Receiving device.
C. Shop drawings will be 11 inch by 17 inch, landscape, bound on the left edge. They will be produced with Microsoft Visio or Autodesk AutoCAD software. Documents will be submitted electronically in portable document format (PDF). At the request of the Owner, shop drawings will also be submitted in the native CAD format.

1. Floor plans indication the locations for; control panels, temperature sensors, thermostats, humidity sensors, and humidistats.
2. Anticipated elevations of locations for; temperature sensors, thermostats, humidity sensors, and humidistats with all wall mounted devices shown.
3. Bill of materials of equipment indicating quantity, manufacturer, and model number.
4. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
5. Controlled Systems:
   a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
   b. A two-dimensional cross sectional diagram showing key components such as fans, coils, dampers, valves, pump, etc.
   c. Identify the locations and names of all sensors and end devices that are associated with the control system. Label the panel name and terminal numbers where the connections are landed.
   d. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
   e. Written description of sequence of operation including schematic diagram.
   f. Points list.
   g. A legend will be provided for all symbols used.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. System Architecture Design Diagram
   a. This is a riser diagram that shall show the IP layer and all of the field bus layers.
   b. It shall show each computer, printer, router, repeater, controller, and protocol translator that is connected to either the IP layer or any of the field busses.
   c. Each component that is shown shall have a name that is representative of how it will be identified in the completed database and the manufacturer's name and model number.
   d. The physical relationship of one component to another component will reflect the proposed installation.
   e. This diagram shall not include power supplies, sensors or end devices.
9. Layout Design Drawing for each control panel:
   a. The layout drawing will be to scale with devices shown in their proposed positions.
   b. Control devices will be identified by name.
   c. Terminal strips and wire channels will be shown.
   d. Control transformers will be shown.
   e. 120 VAC receptacles will be shown.
   f. IP connection points will be shown.
10. Wiring Design Diagram for each control panel.
   a. The control voltage wiring diagram will clearly designate devices powered by each control transformer. The diagram will clearly show the consistent grounding of the appropriate power connection. Wire identification numbers will be annotated on the diagram.
   b. The Field Bus wiring diagram will clearly show the use of the daisy chain wiring concept, the order in which the devices are connected to the Field Bus, and the location of end of segment termination devices. Wire identification numbers will be annotated on the diagram.
   c. If shielded communication wiring is used, the grounding of the shield will be shown.
   d. The terminal strip wiring diagram will identify connections on both sides of the terminal strip. Wiring label numbers for wiring leaving the control panel will be annotated on the diagram.
11. Wiring Design Diagram for individual components (controllers, protocol translators, etc.): The wiring diagram for each component will identify all I/O, power, and communication wiring and the locations on the terminal blocks to which the wires are landed.

12. Installation Design Detail for each I/O device.
   a. A drawing of the wiring details for each sensor and/or end device.
   b. For devices with multiple quantities, a standard detail may be submitted.

13. Description and details regarding available control system expansion and methodology for adding additional systems and components.

14. Description and details regarding how system meets project requirements upon loss of power.

15. Dashboard graphics:
   a. “Cartoon” storyboard outlining hierarchy and configuration of each dashboard.
   b. Proposed graphic standards (colors, page design, logos, etc.)
   c. Color printed images of representative screens.

16. BACnet Compliance Documentation:
   a. BACnet Interoperability Building Blocks (BIBBs) and PICS Statement: Submit up-to-date PICS and BIBBs statements for each controller and workstation showing ANSI/ASHRA 135-2004 BACnet communication protocol standards that identifies all of the portions of BACnet that the vendor adheres to. The PIC statement must show conformance to the BACnet devices the vendor proposes to use. The vendor PICS statement will contain the following:
      1) BACnet protocol revision
      2) Applications software and firmware revision
      3) Vendor and BACnet object description
      4) BIBBs supported by the device
      5) The standardized BACnet device profile to which the device conforms
      6) The non-standardized BACnet device application services
      7) A list of all standard and proprietary object types that are supported
      8) For each object type that is supported, the University requires the following:
         (a) Optional properties that are supported with the device or BACnet server
         (b) A list of properties that can be written using BACnet services
         (c) Any object that can be dynamically created or deleted using BACnet services
         (d) Any restrictions in the data value range for properties
      9) Data link layer options supported
      10) Device address binding (necessary for two-way communication with MS/TP devices)
      11) Networking options (BBMD, MS/TP)
      12) Character sets supported
      13) Segmented requests or responses supported

D. Software files will be submitted on fully labeled CDs or USBs that will include a table of contents file in PDF format that provides a description of all of the files on the CD.

1. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
2. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

E. Training manuals for each Training Course:

1. Submit the following six weeks in advance of the training:
   a. List of training objectives.
   b. Outline of the course with time allocations per topic.
   c. Training presentation material (slides, word documents, etc.).
   d. Copy of training reference material (product manuals to be used, etc.).
   e. Schematic of the training equipment to be used with model numbers on each component.
   f. A description of the measurement devices to measure training effectiveness (quizzes, programming exercises, course exam).
g. Instructor’s name and resume with an emphasis on experience in presenting training programs.

F. Startup testing plan: Submit a start up testing plan for each unique system.

1. The purpose of a startup test is to demonstrate the completeness of the physical tasks associated with installation and the performance of the components.
2. For each task on the startup test checklist, the plan shall require the technician to enter his or her initials and the date the test was completed along with any recorded data such as voltages, offsets, or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.
3. Required elements of the startup testing include:
   a. Measurement of voltage sources, primary and secondary.
   b. Verification of proper controller power wiring.
   c. Verification of component inventory when compared to the submittals.
   d. Verification of labeling on components and wiring.
   e. Verification of connection integrity and quality (loose strands and tight connections).
   f. Verification of bus topology, grounding of shields and installation of termination devices.
   g. Verification of point checkout.
      1) Each I/O device is landed per the submittals and functions per the sequence of control.
      2) Analog sensors are properly scaled and a value is reported.
      3) Binary sensors have the correct normal position and the state is correctly reported.
      4) Analog outputs have the correct normal position and move full stroke when so commanded.
         (a) Analog outputs shall be tested to verify that any controlled pneumatic devices travel full stroke when the AO is varied from 0% to 100% output.
      5) Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
   h. Documentation of analog sensor calibration (measured value, reported value and calculated offset).
   i. Documentation of loop tuning (sample rate, gain and integral time constant).
4. Submit at least two weeks prior to equipment startup.

G. Startup testing report.

1. Startup testing reports will be submitted on a per system basis.
2. Startup testing reports will be the documented results of the executed startup testing plans.

H. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: Provide compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

I. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

J. Record Documentation

1. Provide three (3) bound copies of Owner's Manuals (i.e. equipment Data drawings with sequence of operations, Operational Manuals, As-built drawings, etc.)
2. Include control equipment drawings. Drawings will include network diagrams, panel layout drawings, detailed equipment drawings, description of operation, wiring diagrams, termination details, point schedules; trunk layouts including power supplies at all bus levels, and room schedules. Drawings will be “B” sized 11 inches x 17 inches. Include in the submittals a detailed point list for each integrated building. The point list will detail the point descriptor, the type of input or output (i.e., DI, DO, AI, AO) and software points. The point list must be submitted to the Owner’s Representative for review and approval.
3. As-built drawings will each be stamped “As-Built” and have the as-built date on them. Copies of as-built drawings will include the following at a minimum: Detailed drawings for each piece of controlled and monitored equipment, point lists, sequence of operations, and hardware with part information, logic tables, room schedules, and O & M manuals. As part of the as-built drawings; provide a drawing that shows the detailed routing of all communication trunk wires (building-to-building and within building), locations of all network and integration devices, front-end workstations, UPS and campus network/LAN connections.

4. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

5. Provide electronic copies of as-built documentation to the University. The electronic copies will be stored on CDs and will be saved in an editable format. Acceptable formats include Microsoft Office program formats (i.e. Word, Excel, Access, etc.), Visio, and AutoCAD. Other formats must be approved by the University at time of project award.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Startup Personnel Qualifications: Specially trained personnel, in the direct employ of manufacturer or franchise of the primary automatic-control-system provider, who are experienced with the installation and startup of automatic control systems installations similar to those required for this Project.

D. Codes and Standards: Equipment, materials, and labor; provided as work of this section shall comply with federal, state, and local standards, codes, and ordinances.

E. Comply with ASHRAE 135 for DDC system components.

1.10 OWNERSHIP OF PROPRIETARY MATERIAL

A. The University shall retain all rights to software for this project.

B. The University shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition off this contractor. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. The licensing agreement shall not preclude the use of the software by individuals under contract to the owner for commissioning, servicing, or altering the system in the future. Use of the software by individuals under contract to the owner shall be restricted to use on the owner’s computers and only for the purpose of commissioning, servicing, or altering the installed system.

D. Project developed software, files and documentation shall become the property of the owner. These include but are not limited to:

1. Server and workstation software
2. Application programming tools
3. Configuration tools
4. Addressing tools
5. Application files
6. Configuration files
7. Graphic files
8. Report files
9. Graphic symbol libraries
10. Documentation.
1.11 DELIVERY, STORAGE, AND HANDLING
A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
B. System Software: Update to latest version of software at Project completion.

1.12 COORDINATION
A. Alarms: Coordinate with Energy Management the software procedures for specific types of alarm lockouts. Coordinate high and low alarm limits for analog input points. Critical digital input points shall be programmed as alarm-able points.
B. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
C. Coordinate the location and installation of automatic control dampers, instruments, and air control accessories. Automatic control dampers, instruments, and air control accessories will be installed according to Division 23 Section Duct Accessories.
D. Coordinate the location and installation of automatic control valves, instrument wells, and hydronic accessories. Control valves, instrument wells, and hydronic control accessories will be installed according to Division 23 Section Hydronic Piping.
E. Coordinate the location and installation of automatic control valves, instrument wells, and steam accessories. Control valves, instrument wells, and steam control accessories will be installed according to Division 23 Section Steam and Condensate Piping.
F. Coordinate the location and installation of automatic control valves, instrument wells, and plumbing control devices. Control valves, instrument wells, and plumbing control devices will be installed according to Division 22.
G. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
H. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
I. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
J. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.
K. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.
L. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
M. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
N. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
O. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
P. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

1.13 TRAINING
A. Meet all applicable Training requirements of Division 1, Division 21-23, and the following:
1. Instruct the operators how to accomplish control of the system. Include basic troubleshooting and override of equipment and controls in the event of system failure.

2. Training Allowance: Provide not less than (4) hours formal training to the Owner’s designated operations personnel.

3. Trainers - Persons conducting the training shall hold an advanced certification, be knowledgeable in the workings of the system, and shall be regularly engaged in training exercises, so as to provide effective training. Acceptability of the trainers shall be at the discretion of the Owner.

4. Training Manuals - Include the following in training manuals.
   a. Manufacturer’s training brochures.
   b. Operation and maintenance manuals.
   c. Completed Field Acceptance Test Procedure.
   d. “As-installed” Drawings.
   e. Manufacturer’s Operation Manuals.
   f. Software interaction sheets to be used in instructing students how to use the control system, on a command-by-command basis.

5. Training Classes - Prior to conducting training, prepare and submit for approval the proposed training literature and topics. Submit this information at least two weeks prior to the first class.

6. Provide approved training manuals to the Owner at least one week prior to the first class.

7. Provide Audio Visual Tutorials both in a CD format and on the manufactures website instructing on the operation of the programming software tools as provided under this specification.
   a. As part of the training deliverable provide short video clips (each clip shall be a file) of various procedures such as but not limited to the following: Changing a Set point, Making Schedule Adjustments, Modifying Holiday Schedules Adding Special Events, Creating a Backup of the Database Running on the Supervisor, Adding a Schedule to the Database and Linking the Schedule to a Piece of Equipment, Adding a new Schedule to the Graphical User Interface, Using History Chart Builder to Save Your Trends on the Supervisor, Adding a Point to the Existing System, Adjusting the Value of a Point that has been Added to the System, Adding ModBus Points and/or Controllers to theE network.
   b. Video files shall be accessible thru the terminal in such a manner to allow for viewing in order to perform such changes on the BAS.

1.14 WARRANTY

A. Components, system software, parts and assemblies will be guaranteed against defects in materials and workmanship for one year from the acceptance date.

B. Labor, equipment, material, and software required to troubleshoot, repair, reprogram, or replace system components will be provided, at no charge to the owner during the one year warranty period.

C. Corrective software modifications made during warranty service periods will be updated on all user documentation and on user and manufacturer archived software disks. Provide the owner with a new compact disc whenever software changes are required.

D. Install current version DDC system and configuration software fix packs and patches at no cost to the University during the warranty period.

E. Install current version DDC system and configuration software version upgrades released during the warranty period at no cost to the University.

F. The installer will be capable of doing any repairs with factory trained technicians operating out of a local service office.

G. The installer will be capable of doing any repairs with factory trained technicians operating out of a local service office, and furnish the Owner with a local telephone number and email address where a factory-trained technician may be reached at all times.
H. The factory-trained technician shall arrive at the job-site ready to service the system within two hours upon receiving a request for repairs and will prosecute the work continuously until the system is back in proper reliable operating condition.

I. The installer will keep a permanent maintenance record at the local service office of all repairs performed and all service calls responded to during the warranty period (including labor and material used); copy of record will be presented to Owner's representative at completion of each service call.

J. Permanent maintenance records will include dial-up-type service calls made via the dial-up communications feature.

K. System components and local service will be available for a total of seven years.

L. The installer will furnish the Owner with a local telephone number where a factory-trained technician may be reached at all times.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Primary control equipment shall be manufactured by either Siemens Branch, Johnson Controls Branch, or Honeywell Branch.

B. All applicable devices shall be BTL (BACnet Testing Laboratories) Certified installers.

2.2 CONTROL SYSTEM

A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multi-user, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.3 INSTALLATION

A. The University’s Master Systems Integrator will provide discovery and integration into the BAS (Building Automation System) / BMS (Building Management System). The University will maintain a direct relationship with the BAS Master Integrator. All discovery, importation, intergradation, and graphics of all new components and/or systems installed will be performed by the Master Integrator.

B. Temperature control and building automation systems shall be provided and installed by factory branch operations only. Distributors or independent contractors shall not be permitted.

C. BLN (Building Level Network) wiring will be the responsibility of the (controls/general) contractor selected for perform the work.

2.4 BASIS OF DESIGN

A. Wayne State University (WSU) owns and maintains an existing Siemens Desigo CC Building Management System (BMS). Siemens Desigo CC is a native BACnet workstation and has been developed to conform to the BACnet Testing Laboratories “BACnet Advanced Workstation” (B-AWS) test specification. Desigo CC integrates control over a wide range of systems and is designed to communicate with Electrical and Direct Digital Controls (DDC) through building level controllers (Field panels, System Network Controllers, etc.) for the management of central plant equipment, building ventilation equipment, supplemental heating and cooling equipment, and terminal units connected to its communication trunks.
B. The WSU Desigo CC BMS shall provide an interface for building level controllers and associated field level devices to provide application control functions over the field systems. The BMS shall be capable of executing application control programs to provide:
1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Integration of BACnet, MODBUS, OPC-DA, and SNMP controller data
6. Network management for BACnet based devices

2.5 BACNET INTEROPERABILITY:
A. BACnet interoperability refers to the ability to integrate BACnet products made by different manufacturers into a single system.

B. Unless otherwise specified by WSU, all components and controllers will require integration via BACnet and will adhere to the ASHRAE 135-2016 BACnet Standard to ensure interoperability between all systems. BACnet devices shall be via Ethernet (BACnet IP) and or RS-485 (BACnet MSTP) as specified.

C. Other acceptable industry-standard, open communication is currently limited to the following protocols:
   1. MODBUS IP - MODBUS IP communication
   2. OPC DA - OLE for Process Control, OPC DA 2.05, 3.0
   3. SNMP - SNMP Agents monitoring (V1 and V2)
   4. IEC 61850 - protocol for electrical substations and devices

D. Each BACnet device must be BTL (BACnet Testing Laboratories) listed and the devices supplier must show a Protocol Implementation and Conformance Statement (PICS) document and associated BACnet Interoperable Building Blocks (BIBBs) showing the installed devices compliance level.

E. Supplied software shall employ object-oriented technology (OOT) for representation of all data and controlled devices within the WSU Desigo CC BMS. Contractors shall convey all legal copies, legal licensing, and provide unrestricted/unlimited administrative access (administrative user account and password) for all configuration tools, management tools, and utilities used to install, commission, and operate equipment to the Master Systems Integrator and Wayne State University at project close out.

F. Contractors will be responsible to configure BACnet building controllers to serve BACnet data to the WSU Desigo CC BMS installed on the WSU IT network. Each BACnet building controller shall be configured and programmed to expose all BACnet Objects associated with devices that need to be supervised by the BACnet Building Controller. Contractors shall configure the BACnet Building Controllers to utilize a Change of Value (COV) subscription with the WSU Desigo CC BMS server. COV increments shall be set (tuned) to minimize network traffic.

G. All controller communication to the WSU Desigo CC BMS server requires the use of BACnet Broadcast Management Device configuration (BBMD). The BMS Master Systems Integrator maintains the BBMDs on the building automation networks and will expand the BACnet Distribution Table (BDT) as needed for the project. Coordination between the MSI and WSU IT may be required to determine the appropriate server level setup for proper BACnet network communication. Contractors shall provide proper personnel skilled at BBMD and IT configuration to work with the MSI personnel as needed.

2.6 SYSTEM ARCHITECTURE
A. The DDC system architecture shall consist of two layers, the TCP/IP layer and the field bus layer.

B. The TCP/IP layer connects all of the buildings on a single dedicated and isolated network. Fixed IP addresses for connections to the University private DDC network shall be used for each device.
C. BACnet Building Controllers (B-BC) shall be used to connect each field bus to the TCP/IP layer.

2.7 NETWORKING

A. IP Network: Devices that connect to the wide area network (WAN) shall be capable of operating at 100 megabits per second.

B. IP-to-Field Bus Routing Devices
   1. BACnet Building Controller shall be used to provide this functionality.
   2. These devices shall be configurable locally with RS232 or IP crossover cable and configurable via the IP network.
   3. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

C. Field Bus
   1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.

D. Repeaters
   1. Where repeaters are required to connect two segments, repeaters shall be installed in an enclosure mounted in an accessible area.

2.8 BUILDING LEVEL CONTROLLERS (B-BC)

A. Building level DDC controllers shall be microprocessor-based, multi-tasking, multi-user, real-time digital control processors fully capable of being integrated with the operator workstation, or any third party BACnet workstation.

B. Building level DDC controllers shall utilize BACnet open standard communication protocol. Building level controllers shall communicate using BACnet/IP.

C. A BACnet Building Controller (B-BC) as defined by ASHRAE Annex L is a general purpose, field programmable device capable of carrying out a variety of building automation and control tasks. It enables the specification of the following:
   1. Data Sharing
      a. Ability to provide the values of any of its BACnet objects
      b. Ability to retrieve the values of BACnet objects from other devices
      c. Ability to allow modifications such as scheduling and present value of some or all of its BACnet objects by another device.
   2. Alarm and Event Management
      a. Generation of alarms / events notifications and the ability to direct them to recipients using the BACnet intrinsic alarming method
      b. Maintain a list of unacknowledged alarms / events retrievable using standard BACnet Services
      c. Maintain a list of alarms / events retrievable using standard BACnet Services
      d. Notifying other recipients that the acknowledgment has been received
      e. Adjustment of alarm / event parameters
   3. Scheduling
      a. Ability to schedule output actions, both in the local device and in other devices, both binary and analog, based on date and time
   4. Trending
      a. Collection and delivery of (time, value) pairs
   5. Device and Network Management
      a. Ability to respond to information about its status
      b. Ability to respond to requests for information about any of its objects
      c. Ability to respond to communication control messages
      d. Ability to upload its configuration and allow it to be subsequently restored
D. If Building Controllers have embedded I/O, all of the requirements for I/O that are described under Unit Level Controllers shall apply.

E. The B-BC device(s) shall support all ANSI/ASHRAE 135-2004 standard object required and optional properties. BACnet intrinsic alarming is required. Objects and object properties shall be supported so that alarms are sent from the BACnet device without having to be solicited from the University BACnet Operators Workstation (BOWS).

F. DDC panels and devices must utilize ANSI/ASHRAE 135-2004 BACnet Communications Protocol on a single building level network. BACnet communications must not cause derogated communications on the sites existing temperature control network. Derogation includes router, switch, or hub lockups, BACnet building controller lockups, excessive site network slowdowns, unnecessary and repeated ‘who is’ messages. Refer to NIST BACnet standard for definition of unnecessary that-is messages.

G. University BACnet Required Protocol Services supported:
   1. Acknowledge Alarm
   2. Confirmed Event Notify
   3. Get Alarm Summary
   4. Get Enrollment Sum
   5. Add List Element (for the purpose of allowing the addition of a recipient to the BB-C)
   6. Remove List Element (for the purpose of allowing the deletion of a recipient to the BB-C)
   7. Read Property
   8. Read Property Multiple
   9. Write Property
   10. Write Property Multiple
   11. Confirm Private Xfer
   12. I AM
   13. I Have
   14. Unconfirmed COV Notify
   15. Unconfirmed Event Notify
   16. Time Synchronization
   17. Who Has
   18. Who Is
   19. UTC Time Sync
   20. Get Event Info

H. Building controllers must be capable of having their databases uploaded, downloaded and viewed from the building operator workstation.

I. Building level controllers shall have a local port that can connect to a laptop PC or other hand-held tool for local service work, troubleshooting, etc. Each controller shall include the capability to store, retrieve and print alarm summaries, trends and other critical point summaries or reports.

J. Memory: Each DDC controller shall have sufficient memory to support its own operating system and databases and continuous trending on all analog points for that controller (AV, AI, and AO) based on 300 sample intervals.

K. Integrated On-line Diagnostics: Each DDC controller shall continuously perform self-diagnostics and communication diagnosis of all associated unit level equipment. The DDC controller shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC controller and shall not require the connection of an auxiliary I/O device.
L. Power Fail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all DDC controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery back up shall be provided to support the real-time clock and all volatile memory for a minimum of seventy-two (72) hours. Upon restoration of normal power, the DDC controller shall automatically resume full operation without manual intervention. Should a DDC controller memory be lost for any reason, the user shall have the capability of reloading the DDC controller via the local area network or via the local interface port.

M. System architectural design shall eliminate dependence upon any single device, front-end or higher level of controller for alarm reporting and control execution. Each DDC controller shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

N. Building level DDC controllers shall be able to access any data from, or send control commands and alarm reports directly to any other building level controller or combination of controllers on the IP network without dependence upon a central processing device. Building level DDC controllers shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

O. Ethernet network communications will use 100 MBPS communication rates or greater.

2.9 UNIT LEVEL CONTROLLERS

A. Each Unit Level DDC controller shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, input and output (DI, DO, AI, AO) capabilities.

B. Unit level DDC controllers shall utilize BACnet/MSTP or LON open standard communication protocol.

C. Unit level controllers, including VAV controllers, must be able to have their databases uploaded, downloaded and viewed from the building operator workstation.

D. Power Fail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of DDC controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for critical controller configuration data, and battery back up shall be provided to support the real-time clock and all volatile memory for a minimum of seventy-two (72) hours. Upon restoration of normal power, the DDC controller shall automatically resume full operation without manual intervention. Should a DDC controller memory be lost for any reason, the user shall have the capability of reloading the DDC controller via the local area network or via the local interface port.

E. Each controller will be programmed such that each controlled device will have a default value in which to be commanded to in the event of a control sensor failure. The acceptable default values are, last command, full open, or full closed.

F. Controller I/O Requirements

1. Analog Input Circuits
   a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
   b. For non-flow sensors, the control logic shall support a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
   c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
d. For non-linear sensors such as thermistors and flow sensors the controller shall provide software support for the linearization of the input signal.

2. Binary Input Circuits
   a. Dry contact sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.

3. Pulse Input Circuits
   a. Pulse input sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.
   c. The pulse input circuit shall be able to process up to 20 pulses per second.

4. True Analog Output Circuits
   a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range.
   b. The resolution of the D/A chip shall not be less than 0.04 Volts per increment or 0.08 milliamps per increment.

5. Binary Output Circuits
   a. Single pole, single throw or single pole, double throw relays.
   b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.

6. Program Execution
   a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
   b. The sample rate for a process control loop shall be adjustable and shall support a maximum sample rate of 1 second.
   c. The sample rate for process variables shall be adjustable and shall support a maximum sample rate of 1 second.
   d. The sample rate for algorithm updates shall be adjustable and shall support a maximum sample rate of 1 second.
   e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.

7. Local Interface: The controller shall support the connection of a portable interface device such as a laptop computer or vendor specific hand-held device. Via this local interface, an operator shall be able to:
   a. Adjust application parameters.
   b. Execute manual control of input and output points.
   c. View dynamic data.

G. Unit level controllers shall not be dependent upon any other controller (unit or building level) to maintain safe operation of the controlled equipment.

H. PROHIBITED: The combination of master/slave panels or point expansion for PID control loops.

I. PROHIBITED: Splitting mechanical systems between more than one Unit Level controller.

2.10 DDC EQUIPMENT

A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
   a. Global communications.
   b. Discrete/digital, analog, and pulse I/O.
   c. Monitoring, controlling, or addressing data points.
d. Software applications, scheduling, and alarm processing.
e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:
   a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, anti-short cycling, PID control, DDC with fine tuning, and trend logging.
   b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
   c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
   d. Remote communications.
   e. Maintenance management.
f. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
   1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
   2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
      a. Global communications.
      b. Discrete/digital, analog, and pulse I/O.
      c. Monitoring, controlling, or addressing data points.
   3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
   4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

C. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
   1. Binary Inputs: Allow monitoring of on-off signals without external power.
   2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
   3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
   4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
   5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
   7. Universal I/Os: Provide software selectable binary or analog outputs.

D. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
   1. Output ripple of 5.0 mV maximum peak to peak.
   2. Combined 1 percent line and load regulation with 100-mic.second response time for 50 percent load changes.
   3. Built-in over-voltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
E. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
   1. Minimum dielectric strength of 1000 V.
   3. Minimum transverse-mode noise attenuation of 65 dB.
   4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.11 WAYNE STATE GRAPHICAL AND NAMING REQUIREMENTS

A. Graphics acceptable to the University shall be provided, by the master integrator, for all mechanical and electrical systems and components which are controlled or monitored by the BMS. Graphics must also reside on the University’s central server/control center and be fully visible at the local building’s work station. All terminal device graphics should contain locations such as room numbers the device is serving. It should also note what air handler feeds the device. It should show room set point, room temperature, discharge temperature, damper command, damper position, cfm set point, cfm the unit is putting out, valve command, valve position and mode heat or cool and occupancy or vacancy.

B. Alarms on critical points, components, and systems are an important feature and require review and concurrence by the University during the design development phase of the BMS.

C. Programming shall include optimized start/stop for appropriate mechanical and electrical systems.

D. Point descriptors shall include upper/lower case characters. System or point names such as AHU #1; FEEDWATER PUMP #2; etc. shall be all upper case. For example, “CIRCULATING PUMP #1 - Mechanical Room 235”

E. Point descriptors including room numbers shall represent the University’s assigned nomenclature instead of construction document numbers, if different.

2.12 OPERATOR WORKSTATION INTERFACE

A. Basic Interface Description

1. Operator workstation interface software will minimize operator training using English language prompting, 30 character English language point identification, on-line help, and industry standard PC application software. The software will provide, as a minimum, the following functionality:
   a. Real-time graphical viewing and control of environment
   b. Scheduling and override of building operations
   c. Collection and analysis of historical data
   d. Point database editing, storage and downloading of controller databases.
   e. Alarm reporting, routing, messaging, and acknowledgment
   f. Display dynamic data trend plot.
      1) Must be able to run multiple plots simultaneously
      2) Each plot must be capable of supporting 10 pts/plot minimum
      3) Must be able to command points directly off dynamic trend plot application.
   g. Definition and construction of dynamic color graphic displays.
   h. Program editing
   i. Transfer trend data to third party software
   j. Scheduling reports
   k. Operator Activity Log

2. Provide a graphical user interface that will minimize the use of keyboard with a mouse or similar pointing device and "point and click" approach to menu selection.
3. The software will provide a multi-tasking type environment that allows the user to run several applications simultaneously. BAS software will run on most current version of Windows Professional operating system. These Windows applications will run simultaneously with the BAS software. The mouse will be used to quickly select and switch between multiple applications. The operator will be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BAS alarms and monitoring information.
   a. Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via user-sized windows. Operator will be able to drag and drop information between applications, reducing the number of steps (i.e. Click on a point on the alarm screen and drag it to the dynamic trend graph application to initiate a dynamic trend).
      1) Dynamic color graphics and graphic control
      2) Alarm management, routing to designated locations, and customized messages
         (a) Alarms will be available on remote wireless devices if requested by the University.
      3) Year in advance event and report scheduling
      4) Dynamic trend data definition and presentation
      5) Graphic definition and construction
      6) Program and point database editing on-line.
   b. Report and alarm printing will be accomplished via Windows Print Manager, allowing use of network printers.
   c. Operator specific password access protection will be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges will "follow" the operator to any workstation logged onto (up to 999 user accounts will be supported).
4. Reports will be generated on demand or via pre-defined schedule and directed to CRT displays, printers, or disk. As a minimum, the system will allow the user to easily obtain the following types of reports:
   a. A general listing of all or selected points in the network
   b. List of all points currently in alarm
   c. List of all points currently in override status
   d. List of all disabled points
   e. List of all points currently locked out
   f. List of user accounts and access levels
   g. List all weekly schedules
   h. List of holiday programming
   i. List of limits and deadbands
   j. Custom reports from third party software
   k. System diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points
   l. List of programs
5. Scheduling and Override: Provide a calendar type format for simplification of time-of-day scheduling and overrides of building operations. Schedules reside in the PC workstation, DDC Controller, and HVAC Mechanical Equipment Controller to ensure time equipment scheduling when PC is off-line; PC is not required to execute time scheduling. Provide override access through menu selection or function key. Provide the following spreadsheet graphic types as a minimum:
   a. Weekly schedules
   b. Zone schedules, minimum of 200 unique zones
   c. Scheduling for up to 365 days in advance
   d. Schedule reports to print at PC.
6. Collection and Analysis of Historical Data
a. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period. Any system point may be trended automatically at time-based intervals or change of value, both of which will be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.

b. Trend data reports will be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. DDC contractor will provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. DDC contractor will provide setup of custom reports including creation of data format templates for monthly or weekly reports.

c. Provide additional functionality that allows the user to view real-time trend data on trend graph displays. A minimum of ten points may be graphed, regardless of whether they have been predefined for trending. The dynamic graphs will continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed. A minimum of 8 true graphs will run simultaneously. Operator will be able to command points directly on the trend plot by double clicking on the point.

d. Provide trend reports for the following data: (Each air handling unit)
   1) Duct static pressure.
   2) Supply fan cfm.
   3) Return fan cfm.
   4) Outside air cfm.
   5) Discharge air temperature.
   6) Return air temperature.

B. Dynamic Color Graphic Displays

1. Create color graphic floor plan displays and system schematics for each piece of mechanical equipment to optimize system performance analysis and speed alarm recognition. Color graphic displays will include the following:
   a. Refer to Section 230993 “Sequence of Operation for HVAC Controls” for additional display requirements.

2. Operator Override: The system shall allow the operator to override control sequences and drive open or closed all automatic control dampers and valves.

3. Two position dampers and control valves shall be shown as “OPEN” or CLOSED.”

4. Two position smoke and combination fire/smoke dampers shall be shown as “OPEN” or CLOSED.”

5. Modulating dampers and control valves shall be displayed as a percentage of full open. Zero percent equals closed, and 100-percent equal's full open.

6. Modulating face and bypass dampers shall be displayed as a percentage of airflow through the coil. Zero percent equals closed, and 100-percent equal's full open.

7. The operator interface will allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands. Graphics software will permit the importing of AutoCAD or scanned pictures for use in the system.

8. Dynamic temperature values, humidity values, flow values and status indication will be shown in their actual respective locations and will automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.
   a. Sizable analog bars will be available for monitor and control of analog values; high and low, alarm limit settings will be displayed on the analog scale. The user will be able to "click and drag" the pointer to change the set point.

   b. Provide the user the ability to display blocks of point data by defined point groups; alarm conditions will be displayed by flashing point blocks.
c. Equipment state can be changed by clicking on the point block or graphic symbol and selecting the new state (on/off) or set point.

d. State text for digital points can be defined up to eight characters.

9. Colors will be used to indicate status and change as the status of the equipment changes. The state colors will be user definable.
   a. “Green” will always represent normal operation.
   b. Alarms will be “red”.
   c. Manual Maintenance Mode: Motors that have been manually switched off by the system operator will be “Yellow”.

10. The windowing environment of the PC operator workstation will allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

11. Off the shelf graphic software, Microgafx Designer or Coral Draw software will be provided to allow the user to add, modify or delete system graphic displays.

12. A clipart library of HVAC and automation symbols will be provided including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams, and laboratory symbols. The user will have the ability to add custom symbols to the clipart library.

13. A dynamic display of the site-specific architecture showing status of controllers, PC workstations, and networks will be provided.

C. Web Browser Clients: Provide for a series of browser accessible graphical screens that are resident on the BC and Server that represent the systems controllers and managed by that BC and its associated controllers. The Web browser client shall support at a minimum, the following functions:

1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

3. HTML programming shall not be required to display system graphics or data on a Web page.

4. Storage of the graphical screens shall be in the Building Controller (BC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

5. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.

6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
   a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
      1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
      2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
   b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
   c. View logs and charts.
   d. View and acknowledge alarms.

7. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

D. System Configuration & Definition

1. Network wide control strategies will not be restricted to a single DDC Controller or HVAC Mechanical Equipment controller, but will be able to include data from any and all other network panels to allow the development of Global control strategies.

2. Provide automatic backup and restore of all DDC controllers and HVAC Mechanical Equipment controller databases on the workstation hard disk. In addition, all database changes will be performed while the workstation is on-line without disrupting other system operations. Changes will be automatically recorded and downloaded to the appropriate DDC Controller or HVAC Mechanical Equipment Controller. Changes made at the DDC Controllers or HVAC Mechanical Equipment Controllers will be automatically uploaded to the workstation, ensuring system continuity.

3. System configuration, programming, editing, graphics generation will be performed on-line. If programming and system back up must be done with the PC workstation off-line, the BAS contractor will provide at least 2 operator workstations.

E. Alarm Management

1. Alarm Routing will allow the user to send alarm notification to selected printers or PC location based on time of day, alarm severity, or point type.

2. Alarm Notification will be provided via two alarm icons, to distinguish between routine, maintenance type alarms and critical alarms. These alarm icons will be displayed when user is working in other Windows programs. The BAS alarm display screen will be displayed when the user clicks on the alarm icon.

3. Alarm Display will list the alarms with highest priority at the top of the display. The alarm display will provide selector buttons for display of the associated point graphic and message. The alarm display will provide a mechanism for the operator to sort alarms.

4. Alarm messages will be customizable for each point to display detailed instructions to the user regarding actions to take in case of an alarm.

2.13 DDC SYSTEM SOFTWARE

A. Graphic Page Creation and Editing

1. The Graphics Editor portion of the Engineering Software shall provide the following minimum capabilities:
   a. Create and save symbols.
   b. Create and save pages.
   c. Group and ungroup symbols.
   d. Modify an existing symbol.
   e. Modify an existing graphic page.
   f. Rotate and mirror a symbol.
   g. Place a symbol on a page.
   h. Place analog dynamic data in decimal format on a page.
   i. Place binary dynamic data using state descriptors on a page.
   j. Create motion through the use off gif, jpeg, bmp or svg files
   k. Place test mode indication on a page.
   l. Place manual mode indication on a page.
   m. Place links using a fixed symbol or flyover on a page.
      1) Links to other graphics.
      2) Links to web sites.
      3) Links to notes.
      4) Links to time schedules.
      5) Links to trends.
   n. Assign a background color.
   o. Assign a foreground color.
p. Place alarm indicators on a page.
q. Change a symbol color as a function of an analog variable.
r. Change a symbol color as a function of a binary state.
s. Change symbols as a function of a binary state.
t. Symbols used by the contractor in the creation of graphic pages shall be saved to a library file for use by the owner.

B. Event Logging
1. The system shall maintain a log of all operator activity, system messages, alarms, and alarm acknowledgments.
2. Operator activity is defined as any action by an operator such as changing the value of an application parameter, modifying a program, acknowledging an alarm, logging on, logging off, etc. Any change in the system caused by operator action shall be part of the log. The log shall include the event, the time of the event, the part of the system affected, and an identification of the operator and the OWS from which the change was made.
3. When the event deals with a value change, both the original and new values shall be part of the event record.
4. The Event Log shall be exportable to a report format that is printable.
5. The System Administrator shall be able to archive the event log.
6. The event data shall comply with 21 CFR Part 11 requirements for data integrity.
7. The Event Log shall have a search function with assignable criteria to identify subsets of the event log such as all points placed under manual control, etc.

C. Alarm Generation and Processing
1. Alarm creation is a two part process. The creation of a binary alarm indication is accomplished in a field level device where a binary state of zero shall indicate a normal condition and a binary state of one shall indicate an alarm condition. The binary alarm condition is read within a B-AAC, or Building Controller. The B-AAC or Building Controller shall assign a descriptive message, a category or priority number and a date and time stamp to the alarm and forward the information to the OWS in accordance with an alarm routing table.
2. Alarm parameters such as high limits, low limits, time to state, binary alarm conditions are setup within the programming of the field level devices. These parameters shall be viewable and editable in point lists and on configuration graphic pages.
3. The alarm message shall be descriptive.
   a. Building identification
   b. System identification
   c. Device identification
   d. Date
   e. Time to the second
   f. Nature of the alarm
      1) High value
      2) Low value
      3) Fail to start
   g. Value or state at the time of the alarm.
4. When the operator acknowledges the alarm, there shall be an opportunity to enter a message that becomes a permanent part of the alarm record recorded in the event log.
5. The system shall support the association of graphic pages, trend charts, reports and text documents with specific alarms.
   a. The operator shall have the ability to configure the system to auto-launch a specific graphic page when the alarm occurs.
   b. The system shall support the assignment of wav files to alarm signals on graphic pages.
   c. The operator shall have the ability to launch a specific trend chart from the alarm window when the alarm occurs.
   d. The operator shall have the ability to launch a specific text document when the alarm occurs.
e. An associated report shall automatically execute and write to the hard disk on the OWS when the alarm occurs. Configurations options shall include overwriting the previous report or creating a new file.

6. The system shall use selectable multiple colors on alarm messages for each of the following conditions:
   a. Alarm condition exists and has not been acknowledged
   b. Alarm condition has returned to normal but was never acknowledged
   c. Alarm condition exists and has been acknowledged

7. When an alarm condition no longer exists and has been acknowledged, it shall no longer be displayed in the alarm viewer but it shall be permanently recorded in the event list.

8. The Alarm Routing Table shall support the following:
   a. Multiple workstations at any time.
   b. Specific workstations at particular times (to include all of the time as one choice).
   c. Pagers
   d. Email addresses via simple mail transfer protocol (SMTP; RFC 821)
   e. Permanent comprehensive system wide alarm file
   f. Specific alarm file based on a building or equipment identification
   g. One or more alarm printers at any time
   h. Specific alarm printers at specific times
   i. Rerouting of alarms to a backup receiver when an acknowledgement has not been entered into the system within a specified time.

9. The system shall have a default audible indicator generated by the computer when an alarm is received.

10. Once an alarm is acknowledged at one OWS, it shall display as acknowledged at all operator workstations.

11. An operator shall be able to select multiple alarms for single action acknowledgement.

12. There shall be the ability to disable alarms.

13. The OWS alarm viewer shall be able to display the last 100 active alarms. If there are more than 100 active alarms, as alarms are acknowledged and removed from the viewer, older alarms shall be viewable to keep the viewer showing the last 100 active alarms until there are less than 100 active alarms.

D. Trends

1. Real Time Trends:
   a. At each OWS the operator shall be able to initiate a real time trending instance of up to 10 variables simultaneously.
   b. The polling interval setting shall be adjustable down to a rate of every second.
   c. The data for each instance shall be presented on a single graphical display that automatically updates with each new data collection cycle.
   d. The graphical presentation shall plot the variables on the Y axis and time on the X axis.
   e. A minimum of two Y axis scales shall be available.
   f. The operator shall have the ability to set the range on each Y axis scale or let the scales auto range to cover the range of the values being trended.
   g. Each element of data on the graphical display must be labeled by name or by a unique color. If color is used, a color legend must be included on the graph.
   h. The operator shall be able to open up to five instances simultaneously for a total of 100 points being trended at one time.
   i. An operator shall be able to print an instance of real time data.
   j. The system shall be capable of trending any variable in the system.
   k. The operator shall be able to save pre-configured instances of real time trending that can be initiated with simple point and click actions.

2. Historical Data Collection:
   a. Historical trend data shall be collected by field level devices and periodically uploaded to the data server.
   b. The trend log objects in the field level devices shall have the capacity to store 300 samples per variable. When the 301st sample is collected, the first sample shall be discarded.
c. The field level devices shall be configured to request an upload of data when the number of samples is not greater than 180. Uploads may be configured to occur at a greater frequency.

d. Initiation of historical data collection shall be configurable.
   1) By manual operator intervention in a point and click manner.
   2) By a user adjustable time schedule or date.
   3) Triggered by a binary status variable (when the fan status is on, start the trend of the mixed air temperature).
   4) The system shall be capable of trending any variable in the system.

e. The status and capacity of the trend logs in the field devices shall be viewable from the operator workstation.

3. Historical Data Presentation:
   a. An OWS shall have the capability to present the historical data for a variable in a tabular presentation of the values along with the date and time of the sample. The time period for the values to be presented shall be user adjustable.
   b. An OWS shall have the capability to present the historical data for a variable in a graphical presentation of the values plotted against time and date.
   c. The graphical presentation capabilities for historical trends shall equal those described above for real time trends.
   d. The operator shall be able to save pre-configured instances of historical trending that can be initiated with simple point and click actions.
   e. The operator shall be able to print the tabular presentations and graphical presentations of historical trend data.

4. The data collection, storage, retrieval and presentation system shall provide the features necessary for the owner to achieve certification under 21 CFR Part 11. The key issue is the integrity of the data, the ability to verify that the data has not been modified after collection by the system.

E. Application Programming
   1. The application programming tool may be based on Line Programming or Graphical Programming concepts.
   2. If the application programming is object based and graphical:
      a. There shall be an off-line simulation capability.
      b. There shall be the ability to view dynamic data displayed on the object diagram in real time.
   3. There shall be self checking for errors in programming to be used by the programmer.
   4. Key functions that must be supported are:
      a. Timer functions to include Delay Off, Delay On and Sample Rate Support
      b. Interval timer
      c. Math functions to include Addition, Subtraction, Multiplication, Division, Exponentiation, Trigonometric Functions and Logarithmic Functions (base 2 and base 10)
      d. If-Then-Else Instructions (also referred to as switching logic)
      e. Look up tables with a minimum of 100 entries, with and without extrapolation
      f. Bit Wise Logic
      g. Sample and hold binary
      h. Sample and hold analog
      i. Latch on and latch off functions with resets
      j. Input network variable definition
      k. Output network variable definition
      l. Sensor measurement definition
      m. End device control definition
      n. Logic functions to include And, Or, Not and Exclusive Or
      o. Detection of a power cycle
      p. Common function support (standard objects in graphical programs and subroutines in line programs). As a minimum the common functions shall include:
         1) PID with analog output
         2) PID with tri-state outputs
3) Enthalpy from temperature and relative humidity
4) Optimum start stop based on occupancy schedule, temperature, set point and outside air temperature.
5) Polynomial equation

F. Report Creation
1. The operator shall be able to extract historical data from the data collection files and present the data in a Microsoft Excel format. Data in the log shall be exportable to include the date, time and values.
2. The number of trend logs that can be inserted into a single Excel Workbook shall not be limited by the OWS software.
3. The operators shall be able to pre-configure reports for manual execution or automated execution.
4. The OWS shall be able to auto execute any report based on:
   a. A time schedule
   b. An alarm trigger
   c. The status of a binary point (state=1, execute the report)
5. The operators shall be able to pre-configure the destination of the report:
   a. OWS screen
   b. Write to file on the hard drive
   c. Send to a printer.
6. The generation of a report shall not interrupt the use of the OWS by the operator, that is, it shall execute in the background.

2.14 UNITARY CONTROLLERS
A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72 -hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. Indoor enclosure: Dustproof rated for operation at 32 to 120 degrees F.
5. Outdoor enclosure: Waterproof rated for operation at -40 to 150 degrees F.

2.15 DDC RESIDENT SOFTWARE FEATURES
A. General:
1. The software programs specified in this section will be provided as an integral part of the DDC and HVAC mechanical equipment controllers and will not be dependent upon any higher level computer (or operator workstation) for execution.
2. All points will be identified by up to 30-character point name and 16 character point descriptor. The same names will be used at the operator workstation.
3. All digital points will have user defined two-state status indication (descriptors with minimum of 8 characters allowed per state (i.e. summer/winter)).

B. Control Software Description:
1. The DDC and HVAC mechanical equipment controllers will have the ability to perform the following pre-tested control algorithms:
   a. Two-position control
   b. Proportional control
c. Proportional plus integral control
d. Proportional, integral, plus derivative control
e. Automatic tuning of control loops

C. DDC and HVAC mechanical equipment controllers will provide the following energy management routines.

1. Start-Stop Time Optimization (SSTO) will automatically be coordinated with event scheduling. The SSTO program will start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program will also shut down HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.
   a. The SSTO program will operate in both the heating and cooling seasons.
   b. It will be possible to apply the SSTO program to individual fan systems.
   c. The SSTO program will operate on both outside weather conditions as well as inside zone conditions and empirical factors.
   d. The SSTO program will meet the local code requirements for minimum outside air while the building is occupied.

2. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
   a. It will be possible to individually command a point or group of points.
   b. For points assigned to one common load group, it will be possible to assign variable time delays between each successive start or stop within that group.
   c. The operator will be able to define the following information:
      1) Time, day
      2) Commands such as on, off, auto, and so forth.
      3) Time delays between successive commands.
   d. There will be provisions for manual overriding of each schedule by an appropriate operator.
   e. It will be possible to schedule events up to one year in advance.
      1) Scheduling will be calendar based.
      2) Holidays will allow for different schedules.

3. Enthalpy switchover (economizer). The energy management control software (EMCS) will control the position of the air handler relief, return, and outside air dampers. If the outside air enthalpy falls below changeover set point, the EMCS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly changeover to an economizer system based on enthalpy and will be able to override the economizer cycle and return to minimum outside air operation at any time.

4. Temperature-compensated duty cycling.
   a. The DCCP (Duty Cycle Control Program) will periodically stop and start loads according to various patterns.
   b. The loads will be cycled such that there is a net reduction in both the electrical demands and the energy consumed.

5. Automatic Daylight Savings Time Switchover: The system will provide automatic time adjustment for switching to/from Daylight Savings Time.

6. Night setback control: The system will provide the ability to automatically adjust set points for night control.

7. The Peak Demand Limiting (PDL) program will limit the consumption of electricity to prevent electrical peak demand charges.
   a. PDL will continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.
   b. PDL will sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
   c. If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, and then PDL will automatically shed electrical loads.
   d. Once the demand peak has passed, loads that have been shed will be restored and returned to normal control.
D. DDC and HVAC Mechanical Equipment Controllers will be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. A single process will be able to incorporate measured or calculated data from any and all other DDC and HVAC Mechanical Equipment Controllers on the network. In addition, a single process will be able to issue commands to points in any and all other DDC and HVAC Mechanical Equipment Controllers on the network. Database will support 30 character; English language point names, structured for searching, and logs.

2. Processes will be able to generate operator messages and advisories to operator I/O devices. A process will be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.

3. DDC and HVAC Mechanical Equipment Controller will provide a HELP function key; providing enhanced context sensitive on-line help with task orientated information from the user manual.

4. DDC and HVAC Mechanical Equipment Controller will be capable of comment lines for sequence of operation explanation.

E. Alarm management will be provided to monitor and direct alarm information to operator devices. Each DDC and HVAC Mechanical Equipment Controller will perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time will the DDC and HVAC Mechanical Equipment Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device, or communications with other panels on the network.

1. All alarm or point change reports will include the point's English language description and the time and date of occurrence.

2. The user will be able to define the specific system reaction for each point. Alarms will be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels will be provided for each point. Point priority levels will be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC and HVAC Mechanical Equipment Controller will automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users will have the ability to manually inhibit alarm reporting for each point.

3. Alarm reports and messages will be directed to a user-defined list of operator devices or PC’s based on time (after hours destinations) or based on priority.

4. In addition to the point's descriptor and the time and date, the user will be able to print, display, or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.

5. In dial-up applications, operator-selected alarms will initiate a call to a remote operator device.

6. Alarm points will be individually addressed. Do not group alarm points.

F. A variety of historical data collection utilities will be provided to manually or automatically sample, store, and display system data for points as specified in the I/O summary.

1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC and HVAC Mechanical Equipment Controllers point group. Two methods of collection will be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days will be provided. Each DDC and HVAC Mechanical Equipment Controller will have a dedicated RAM-based buffer for trend data and will be capable of storing data samples. All trend data will be available for transfer to a Workstation without manual intervention.

2. DDC and HVAC Mechanical Equipment Controllers will also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms will be provided for operator-selected PID control loops as identified in the point I/O summary.
3. Loop tuning will be capable of being initiated both locally at the DDC and at HVAC Mechanical Equipment Controller, from a network workstation or remotely using dial-in modems. For all loop-tuning functions, access will be limited to authorized personnel through password protection.

G. DDC and HVAC Mechanical Equipment Controllers will be capable of automatically accumulating and storing run-time hours. For digital input and output points, and automatically sample, calculate, and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.

H. The peer to peer network will allow the DDC and HVAC Mechanical Equipment Controllers to access, any data from, or send control commands and alarm reports directly to any other DDC and HVAC Mechanical Equipment Controller. Or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC and HVAC Mechanical Equipment Controllers will send alarm reports to multiple workstations without dependence upon a central or intermediate-processing device. The peer to peer network will also allow any DDC and HVAC Mechanical Equipment Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.

I. The peer to peer network will allow the DDC and HVAC Mechanical Equipment Controllers to assign a minimum of 50 passwords access and control priorities to each point individually. The log on password (at any PC workstation or portable operator terminal) will enable the operator to monitor, adjust, and control the points that the operator is authorized to access. All other points will not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points will be accessible to any base building operators, but only tenant points will be accessible to tenant building operators). Passwords and priorities for every point will be fully programmable and adjustable.

2.16 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Connect building automation system provided controllers for AHUs, Chillers, Boilers, and Pumps to power circuits connected to emergency generator.
1. Refer to electrical plans and EM800 for available emergency power circuits.
2. Controllers for VAV boxes, VRF System, FCUs, Unit Heaters, Exhaust Fans, and Plumbing Systems are not required

B. Where required controllers are not connected to emergency generator power, provide Uninterrupted Power to every level of Controller(s) which make up the control system. Include supporting devices such as air compressors, controlled device power supplies, etc

C. UPS shall be able to power associated BAS system controllers and maintain all programming, data, etc. for a minimum of 4 hours of complete loss of power.

D. When a UPS is required, it shall be an Eaton (MGE/Cutler Hammer), model PULSL1000T or approved equal.
1. Tower or mini-tower model, 1000 VA capacity, with an LCD screen. It shall be equipped with software for remote supervision.
2. The UPS shall be a true UPS meaning the inverter shall be active at all times, not just on a loss of input power.
3. UPS output shall be configured for four (4) 5-15R outlets.
4. Batteries shall be sealed, maintenance-free type.
5. UPS shall have a two year warranty on the assembly, including batteries.
6. IP network management shall be built in or if done via an optional card, included in the supplied hardware.
7. Provide UPS status outputs via relay contacts and an emergency stop.
8. For ease of service, the UPS shall be a plug in type and not hard wired.
9. A limited access outlet is needed to keep the UPS powered in an environment where someone may be in need of an outlet (See Part 3).
2.17 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 degrees F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

2.18 AIR TERMINAL CONTROLLER

A. Controller provides direct digital control for room temperature control in variable air volume systems. The controller will operate independently, stand-alone or networked to perform HVAC control, monitoring and energy management functions without relying on a higher level processor. The controller will include a pressure differential transducer and electronic controller.

B. Control algorithms will be preprogrammed; the operator's terminal may be used to adjust air volume set points and other parameters. The controller will be designed for operation and modification without vendor assistance.

C. The controller will interface with the following external devices:
   1. Averaging air velocity sensor.
   2. Floating control valve and damper actuators.
   3. Temperature sensors.
   4. Portable operators terminal
   5. Building Automation System.
   6. Digital input devices (alarm contacts)
   7. Digital output devices.

D. Controller requirements:
   1. Power requirements:
      a. Operating Range: 18 to 28 Vac.
      b. Power Consumption: 3.5 VA (Nominal) to 5.0 VA (Peak) at 24 Vac.
   2. Analog Inputs:
      a. One room temperature sensor.
      b. One velocity sensor.
      c. One relative humidity sensor.
      d. One set point
      e. One auxiliary temperature sensor.
   4. Outputs: Six DO 24 Vac. optically isolated solid state switches @ 0.5 amps.
   5. Controlled temperature accuracy: plus or minus 1.5°F.
   6. Controlled relative humidity accuracy: plus or minus 2.5% RH.
   7. Communications
      a. Remote: LAN Truck
      b. Local: Portable Operators Terminal.
   8. Ambient Conditions:
      a. Operating Temperature: 32°F to 122°F.
      b. Humidity Range: 10 to 95 percent.

E. Differential Pressure Transducer: The averaging air velocity sensor (provided by the VAV terminal unit manufacturer) sends an average air velocity measurement of the duct air velocity to the controller. The air velocity sensor connects to the differential pressure transducer and measures the average differential pressure. The air terminal controller converts this value to actual airflow in CFM. The controller will report CFM and set points.
F. Differential Pressure Transducer Requirements:
   1. Temperature range: 48°F to 112°F.
   2. Measurement Range: 0 to 4000 fpm.
   4. Measurement Accuracy
      a. 300 to 4000 fpm: Plus or minus 5-percent of actual reading
      b. 200 to 300 fpm: +12-percent to –15-percent of actual reading
   5. Repeatability: Plus or minus 8 fpm.

2.19 PERIPHERAL DEVICES

A. Provide sensors and transmitters required as outlined in the input/output summary and sequence of
   operation, and as required to achieve the specified accuracy as specified herein.

B. Temperature transmitters shall be equipped with individual zero and span adjustments. The zero
   and span adjustments shall be non-interactive to permit calibration without iterative operations.
   Provide a loop test signal to aid in sensor calibration.

C. Temperature transmitters shall be sized and constructed to be compatible with the medium to be
   monitored. Transmitters shall be equipped with a linearization circuit to compensate for non-
   lineairities of the sensor and bridge and provide a true linear output signal.

D. CU operating software shall be equipped with a self-calibrating feature for temperature sensors.

E. Sensors used in BTU or process calculations shall be accurate to ±0.10°F over the process
   temperature range.

F. Space Sensors and Transmitters:
   1. Manufacturers:
      a. Veris Industries
      b. Automation Components, Inc. (ACI)
      c. Johnson Controls Incorporated
      d. Honeywell
      e. Kele Incorporated
      f. Mamac Systems
      g. Schneider Electric
      h. Siemens Building Technologies Incorporated
   2. Space, Humidity and CO2 Sensors may be combined if performance requirements met.
   3. Space Temperature Sensors
      a. Space Temperature Sensor – Public Spaces, Lobby, Audience Chamber, Theater, Cortidors, Classrooms, Studios. BRUSHED STAINLESS STEEL
         1) Accuracy: 0.3 deg. C
         2) Range: 50 to 95 deg F.
         3) Platinum RTD
         4) Wire: Manufacturer’s standard cable assembly
         5) Sensor assembly shall include a temperature sensing element mounted under a flush, 
            standard cover plate size, brushed-stainless steel cover, with an insulated back and
            security screws.
         6) Provide a mounting plate that is compatible with the surface shape that it is mounted to
            and electrical box used.
         7) Concealed wiring connection.
      b. Space Temperature Sensor – Stage, Flex Theater, Control Room, All Spaces that are
         painted black. BLACK
         1) Accuracy: 0.3 deg. C
         2) Range: 50 to 95 deg F.
         3) Platinum RTD
         4) Wire: Manufacturer’s standard cable assembly
5) Sensor assembly shall include a temperature sensing element mounted under a standard cover plate size, black non-yellowing plastic cover, with an insulated back and security screws.

6) Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.

7) Concealed wiring connection.

8) Port: Plug-in portable-operators terminal port; located on the bottom of the cover.

c. Space Temperature Sensor – Non-Sensitive, Regularly Occupied Spaces. **WHITE, OCCUPANCY OVERRIDE**
   1) Accuracy: 0.3 deg. C
   2) Range: 50 to 95 deg F.
   3) Platinum RTD
   4) Wire: Manufacturer’s standard cable assembly
   5) Sensor assembly shall include a temperature sensing element mounted under a standard cover plate size, bright white non-yellowing plastic cover, with an insulated back and security screws.
   6) Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
   7) Concealed wiring connection.
   8) Set-Point Adjustment: Warmer/Cooler control.
   9) Set-Point Indication: Concealed
   10) Override Button: allows the occupant to change the occupied control schedule during the unoccupied cycle for a predetermined period of time.
   11) Port: Plug-in portable-operators terminal port; located on the bottom of the cover.

d. Space Temperature Sensor – Mechanical, Electrical, Telecomm, Custodial Rooms. **WHITE, DISPLAY, OCCUPANCY OVERRIDE**
   1) Accuracy: 0.3 deg. C
   2) Range: 50 to 95 deg F.
   3) Platinum RTD
   4) Wire: Manufacturer’s standard cable assembly
   5) Sensor assembly shall include a temperature sensing element mounted under a standard cover plate size, bright white non-yellowing plastic cover, with an insulated back and security screws.
   6) Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
   7) Concealed wiring connection.
   8) Set-Point Adjustment: Exposed.
   9) Set-Point Indication: LCD display.
   10) Override Button: allows the occupant to change the occupied control schedule during the unoccupied cycle for a predetermined period of time.
   11) Port: Plug-in portable-operators terminal port; located on the bottom of the cover.

4. Space Humidity Sensors
   a. H1 Space Humidity Sensor - **WHITE, NO DISPLAY**
      1) Accuracy: 2% at 50% RH and 70 deg F.
      2) Accuracy including non-linearity, hysteresis, and repeatability: Within 1 percent from zero to 90 percent relative when operating between 60 to 77 deg F (16 to 25 deg C).
      3) Relative Humidity Range: Zero to 100 percent.
      4) Sensor assembly shall include a thin-film capacitance humidity sensing element mounted under a standard cover plate size, bright white non-yellowing plastic cover, with an insulated back and security screws.
      5) Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
      6) Concealed wiring connection.
      7) Port: Plug-in portable-operators terminal port; located on the bottom of the cover.

5. Space CO2 Sensors
a. Space CO2 Sensor – All Spaces except Stage, Flex Theater, Control Room, and all Spaces that are painted black. **WHITE**
   1) Range 0 to 3000 PPM
   2) Accuracy: +/- 30 PPM +/- 2% of measured value
   3) Repeatability: +/- 20 PPM +/- 1% of measured value
   4) Sensor assembly shall include non-dispersive infrared diffusion sampling sensing element mounted under a standard cover plate size, bright white non-yellowing plastic cover, with security screws.
   5) Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
   6) Concealed wiring connection.
   7) Port: Plug-in portable-operators terminal port; located on the bottom of the cover.

b. Space CO2 Sensor – Stage, Flex Theater, Control Room, All Spaces that are painted black. **BLACK**
   1) Range 0 to 3000 PPM
   2) Accuracy: +/- 30 PPM +/- 2% of measured value
   3) Repeatability: +/- 20 PPM +/- 1% of measured value
   4) Sensor assembly shall include non-dispersive infrared diffusion sampling sensing element mounted under a standard cover plate size, black non-yellowing plastic cover, with security screws.
   5) Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
   6) Concealed wiring connection.
   7) Port: Plug-in portable-operators terminal port; located on the bottom of the cover.

G. Outside Air Sensors
   1. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
   2. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element.

H. Duct Type Sensors
   1. Duct mount sensors shall mount in a hand box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement. A neoprene grommet (sealtite fitting and mounting plate) shall be used on the sensor assembly to prevent air leaks.
   2. Duct sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate. Duct sensors probe shall be constructed of 304 stainless steel.
   3. For outdoor air duct applications, use a weatherproof mounting box with weatherproof cover and gasket.

I. Condensate Drain Pan Sensor
   1. Manufacturers:
      a. Kele – SS/SP SS3 with SG1
   2. Condensate overflow switch designed for installation on drain pans. Overflow switch shall have a solid-state electronic probe or magnetic reed switch with all necessary mounting adapters and hardware for drain pan installation. The condensate overflow alarm shall be wired across the normally closed contacts of the condensate switch. Sensor shall include alarm buzzer, flashing LED, and contacts to building automation system.

J. Pressure Transmitters/Transducers:
   1. Manufacturers:
      a. Air Monitor Corporation
      b. BEC Controls Corporation.
      c. General Eastern Instruments.
      d. MAMAC Systems, Incorporated
      e. ROTRONIC Instrument Corporation
2. Static-Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
   a. Accuracy: 1 percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA.
   c. Building Static-Pressure Range: 0- to 0.50-inch water gage.
      1) Indoor shielded static air probe: 316 stainless steel recessed probe with integral volume chamber capable of sensing room pressure within 1 percent of actual pressure. (Example: Air Monitor Corporation model S.A.P./R)
      2) Outside static air probe: 316 stainless steel round probe with parallel plates capable of sensing pressure within 1 percent of actual pressure. Sensing accuracy unaffected by rain or snow or wind velocities less than 40 MPH. (Example: Air Monitor Corporation model S.O.A.P.)
   d. Duct Static-Pressure Range: 0- to 5-inch water gage.

3. Differential Pressure Transmitters and Accessories
   a. General Air and Water Pressure Transmitter Requirements:
      1) Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.
      b. Pressure transmitters shall provide the option to transmit a 0-5VDC, 0-10VDC, or 4-20mA output signal.
      c. Locate transmitters in accessible local control panels wherever possible.
      d. Low air pressure, differential pressure transmitters used for room filter monitoring. Shall be equipped with a LED display indicating the transmitter output signal.
      e. Low Air Pressure Applications (0 to 0.5" WC)
         1) The pressure transmitter shall be capable of transmitting a linear electronic signal proportional to the differential of the room and reference static pressure input signals with the following minimum performance specifications.
            (a) Span: Not greater than two times the design space DP.
            (b) Accuracy: Plus or minus 0.5% of F.S.
            (c) Dead Band: Less than 0.3% of output.
            (d) Repeatability: Within 0.2% of output.
            (e) Linearity: Plus or minus 0.2% of span.
            (f) Response: Less than one second for full span input.
            (g) Temperature Stability: Less than 0.01% output shift per degree F. change.
         2) The transmitter shall utilize variable capacitance sensor technology and be immune to shock and vibration.
   e. Acceptable Manufacturers: Veris, Senva, Setra.

K. Combination Air Flow / Temperature Measurement Station (AFMS):
   1. General: Provide thermal dispersion type, EBTRON, Inc. Gold Series or equivalent combination airflow and air temperature measurement devices where indicated on the drawings and/or control sequences. Each measuring device shall consist of multi-point sensor nodes in one or more probe assemblies with a maximum of sixteen sensor nodes per location, and a single remotely mounted 32-bit microprocessor-based transmitter for each measurement location. Airflow/Temperature measuring devices shall be UL Listed as an entire assembly. Devices in UL-labeled enclosures are not equivalent and are not acceptable without a UL Listing for Standard 873.
      a. Design and installation shall use duct or plenum mounted devices to fullest extent possible.
      b. Fan inlet sensors shall not be substituted for duct or plenum sensor probes.
         1) Exception: where conditions otherwise make duct/plenum installation impractical and justifications of exceptions are reviewed with engineer and manufacturer’s authorized representative.
2) Where fan inlet mounting is otherwise unavoidable, mounting styles shall be indicated on the plans as either “face mounting” or “throat mounting.” Face mounting shall provide no mechanical fastening in the throat or on the surface of the inlet cone and shall be used on all performance-sensitive plenum-type or plug fans.

2. Sensor Assembly: Each sensing point shall independently determine the airflow rate and temperature at each node, which shall then be equally weighted in calculations by the transmitter prior to output as the cross-sectional average. No electronic components other than the sensor elements shall be located at the sensing node. Each ducted sensor probe shall have an integral, U.L. Listed, plenum rated cable. Cable jackets and conductor insulation shall be FEP, Teflon-FEP or Neoflon-FEP. Conductor insulation for internal probe wiring shall be Kynar. Devices which average multiple non-linear variables are not acceptable. Pitot arrays are not acceptable. Devices using chip-in-glass, epoxy-coated or diode-case chip thermistors are not acceptable. Vortex-shedding devices are not acceptable.

   a. Each independent airflow sensor shall have a sensor accuracy of +/-2% of Reading over the entire calibrated airflow range of 0 to 5,000 fpm (25.4 m/s) for ducted or plenum mounted probes, or not less than 0 to 10,000 fpm (50.8 m/s) for fan inlet mounted sensors. All sensor nodes shall be wind tunnel calibrated to at least 16 air velocities against standards that are traceable to NIST.

   b. Each independent temperature sensor shall have a calibrated accuracy of +/-0.14° F (0.08° C) over the entire operating temperature range of -20° F to 160° F (-28.9° C to 71° C) and be calibrated at 3 temperatures against standards that are traceable to NIST.

   c. Devices whose accuracy is the combined and independent accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the calibrated range.

3. Transmitter: Each transmitter shall have a display capable of simultaneously displaying both airflow and temperature. Airflow rate shall be field configurable to be displayed as velocity or volumetric rates, selectable as IP or SI units. Each transmitter shall operate on 24 VAC and be fused and protected from over voltage, over current and power surges. All integrated circuitry shall be temperature rated as ‘industrial-grade’.

   a. Each transmitter shall be capable of transmitting individual velocity and temperature measurements for every sensing point in an array for a single location. The traverse data from each independent sensor shall be available as part of the network data packet transmitted via the BACnet protocol.

   b. Each transmitter shall be capable of communicating with other devices using at a minimum the following interface option:

      1) Combined linear airflow and temperature analog output signals and one RS-485 network interface. This shall include: Two field selectable 0-5VDC / 0-10VDC / 4-20mA (4-wire) outputs, fuse protected and electrically isolated from all other circuitry; plus one field selectable network protocol: BACnet-MS/TP or BACnet-ARCNET. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.

   c. Transmitter shall include the following features: Enhanced Output Integration, Low Airflow Alarm functions for compliance with LEED Outdoor Air Delivery Monitoring credit and ASHRAE Standard 189.1 and a Field Calibration Wizard to simplify field setup for adjustments when desired.

L. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

M. Current Transformers – Provide current transformers with the following features:

   1. The current transformers shall be designed to be installed or removed without dismantling the primary bus or cables. The transformer shall be of a split core design.

   2. The core and windings shall be completely encased in a UL approved thermoplastic rated 94VA. No metal parts shall be exposed other than the terminals.

N. Current Sensing Switches - Current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. Current sensing switches shall consist of a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over current up to twice its trip into range. Acceptable Manufacturer: Senva, Veris.

O. Relays - Relays other than those associated with digital output cards shall be general purpose, enclosed plug-in type with status indicator. Number of contacts and operational function shall be as required.

P. Dirty Filter Differential Air Pressure Switch – Provide for a large diaphragm operated, SPDT switch, exposed adjustment, 1% repetitive accuracy. Acceptable Manufacturer: Dwyer, Cleveland; Dwyer A-302 static tips, or equal.

Q. Status Sensors -
1. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch water gage.
2. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
3. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
   a. Manufacturers:
      1) BEC Controls Corporation.
      2) T.M. Instruments Incorporated
      3) Or Approved Equal
4. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
5. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

R. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.second response time for 50 percent load changes.
3. Built-in over-voltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

S. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

T. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

U. All temperature transmitters, flow transmitters and pressure differential transmitters shall have a digital indication of the sensed variable.

2.20 PNEUMATIC SENSORS

A. Digital-to-Pneumatic Transducers: Convert plus or minus 12-V dc pulse-width-modulation outputs, or continuous proportional current or voltage to zero to 20 psig.
1. Manufacturers:
   a. BEC Controls Corporation.
   b. MAMAC Systems, Incorporated

B. Pneumatic Valve/Damper Position Indicator: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent valve/damper travel.

2.21 AIR FLOW MEASURING STATIONS (AFMS)

A. Pitot Style Fan Inlet Airflow Station: Multi-port traverse probe, self-averaging Pitot tube station measuring total and static pressure.
   1. Manufacturers:
      a. Air Monitor Corporation.
   2. Sensing Manifold: Copper or anodized aluminum manifold with bullet-nosed total and static pressure sensors positioned on equal area basis.
   3. Accuracy: 3-percent of actual air flow.

B. Duct Airflow Station: Combination of air straightener and multi-port, self-averaging Pitot tube station.
   1. Manufacturers:
      a. Air Monitor Corporation.
      b. Dwyer Instruments, Incorporated.
      c. Wetmaster Company, Ltd.
   4. Sensing Manifold: Copper or anodized aluminum manifold with total and static pressure sensors positioned on equal area basis.
   5. Accuracy: 2-percent of actual air flow.
   6. Velocity Range: 100 to 10,000 fpm.

C. Thermal Dispersion Fan Inlet Airflow Station: Thermal dispersion type station measuring temperature and air flow.
   1. Manufacturers:
      a. Ebtron model GTx116-B
      b. Ruskin
      c. Air Monitor Corporation
   2. Sensing Manifold: Multi-point "bead- in-glass", hermetically sealed thermistor sensors mounted on adjustable length, cadmium plated rods with type 304 stainless steel feet and sensor block.
      a. Provide transmitter that will average up to four sensors and provide two field selectable linear analog output signals (4-20mA and 0-10 VDC) proportional to airflow and temperature. Sensor electronic circuitry other than the temperature sensors shall not be exposed to the air stream and shall be protected from moisture to prevent failure.
   3. Sensor Probe Configuration: 2x1 for single inlet fans or 4x1 for dual inlet fans. Independently wired sensors.
   5. Airflow Sensor Accuracy: ±2% of reading
   6. Calibrated Range: 0-10000 FPM
   7. Temperature Sensor Accuracy: ±0.15°F
   8. Temperature: -20°F to +160°F
   9. Relative Humidity: 0 to 99% (non-condensing)

D. Duct Airflow Station: Thermal dispersion type station measuring temperature and air flow.
   1. Manufacturers:
      a. Ebtron.
      b. Model GTx116-P
      c. Air Monitor Corporation
      d. Or Approved Equal
2. Sensing Manifold: Multi-point “bead in glass” hermetically sealed thermistor sensors mounted in anodized 6061 aluminum alloy tubes with type 304 stainless steel mounting brackets.
   a. Provide transmitter that will average up to sixteen sensors and provide two field selectable linear analog output signals (4-20mA and 0-10 VDC) proportional to airflow and temperature. Sensor electronic circuitry other than the temperature sensors shall not be exposed to the air stream and shall be protected from moisture to prevent failure.

3. Sensor probe configuration: 2x8 or 4x4 independently wired sensors.


5. Airflow Sensor Accuracy: ±2% of reading

6. Calibrated Range: 0-5000 FPM

7. Temperature Sensor Accuracy: ±0.15°F

8. Temperature: -20°F to +140°F

9. Relative Humidity: 0 to 95% (non-condensing)

10. Duct mounted Probe Sensor Density:
    a. Area (sq. ft.)  Sensors
    b. <= 1.5  2
    c. >1.5 to <4  4
    d. 4 to <8  6
    e. 8 to <12  8
    f. 12 to <16  12
    g. >=16  15

E. Round Duct Airflow Station: Thermal dispersion type station measuring temperature and air flow.

1. Manufacturers:
   a. Ebtron
   b. Air Monitor Corporation
   c. Or Approved Equal

2. Model ELF/N RS-485
   a. Sensing Manifold: Multi-point “bead in glass” hermetically sealed thermistor sensors mounted in anodized 6063 aluminum alloy tubes with integral transmitter enclosure and type 5052 aluminum alloy mounting bracket.
   b. Transmitter will average two sensors and provide two field selectable linear analog output signals (4-20mA and 0-10 VDC) proportional to airflow and temperature. Sensor electronic circuitry other than the temperature sensors shall not be exposed to the air stream and shall be protected from moisture to prevent failure.
   c. Transmitter to include DIP-switch accessible on side of enclosure for field set up and selection of RS-485 BACnet MS/TP or Modbus communication interface with building automation system.

3. 3 ft. probe/transmitter cable length.

4. Sensor probe configuration: 1x2 independently wired sensors.

5. Sensor Distribution: Equal area.

6. Airflow Sensor Accuracy: ±2% of reading

7. Calibrated Range: 0-3000 FPM

8. Temperature Sensor Accuracy: ±0.15°F

9. Temperature: -20°F to +140°F

10. Relative Humidity: 0 to 99% (non-condensing)

11. Round Duct Size Limits: minimum 4 in. dia. to maximum 16 in. dia.

F. Integral airflow monitoring dampers

   a. Manufacturers: Subject to compliance with requirements, provide control damper products by one of the listed manufacturers:
      1) Ruskin Manufacturing Company
      2) Air Monitor Corporation
      3) Or Approved Equal

   b. Construction:
1) Frames: Extruded aluminum hat channels, 0.125-in. minimum thickness with mounting flanges on both sides of the frame.
2) Blades: Airfoil shaped extruded aluminum. Anodized monitoring blades are fixed within the damper frame and contain air pressure sensing ports.
3) Hardware: Molded synthetic bearings. Zinc plated steel axles, linkage brackets, connecting rods, and mounting bolts.
4) Seals: Flexible metal compression seals on the frame at blade end; extruded vinyl inflatable blade edge seals.

c. Leakage: Not more than 2 CFM per square foot damper area at differential pressure of 1-inch w.g. with applied torque at damper of 50 inch-pounds.
d. Operating Temperature: -22°F to 140°F.
e. Monitoring Velocity Range: 300 FPM to 2000 FPM.
f. Pressure: 2 inches w.g. maximum differential.
g. Pressure Drop: 0.13-inches w.g. at 1000 fpm.
h. Digital Controller: Application specific controller. Programming and logic in a nonvolatile EPROM.
i. Air Straightener Section: 5-inches long sleeve attached to the damper frame.
j. Damper sizes will be provided as indicated on the drawings. Damper sizes may be provided differently from those shown on the drawings, if improved performance can be demonstrated with calculations.

2.22 VALVES AND ACTUATORS

A. Hardware Warranty - Ball Valves, Ball Valve Actuators and Electronic Valve Actuators for Butterfly Valves shall be covered by a 4 year product warranty from the date of substantial project completion. Industrial-type Electronic Valve Actuators and Butterfly Valves shall be covered by a 36 month product warranty from date of substantial project completion.

B. Labor Warranty - All labor to replace failed Valves and Actuators shall be provided during the first 12 months of the warranty starting from the date of project completion.

C. Approved manufacturers:
   1. Belimo
   2. Siemens
   3. Honeywell

D. Electronic Air Damper Actuators:
   1. Electronic actuators shall be UL listed under standard 873, CUL, and have a CE certification. Electronic actuators shall be produced in accordance to ISO 9002 quality certification standards in a certified production facility.
   2. Electronic air damper actuators shall be capable of coupling directly to the damper shaft. Standard actuator mounting clamp shall be operated with a single fastener, and shall center the damper shaft in the actuator spline (hollow-shaft), with toothed edges gripping four sides of the shaft. Clamps that do not center the shaft, and as such require concentric motion for operation, are not acceptable. Universal U-shaped bolts, single point, or set screw type fastening techniques are not acceptable. Adaptors form fit to the damper shaft are acceptable.
   3. All electronic actuators shall include a manual positioning feature to allow for the full rotation of the actuator, in each direction with or without electrical power applied.
   4. All actuators shall be designed, developed, life cycle tested and manufactured with a high performance, brushless DC motor to offer a constant running time, independent of torque load and offer maximum product reliability and life expectancy. DC motors with brushes are not acceptable.
   5. Actuators shall be fully modulating / proportional and accept both 2…10 VDC and 0…10 VDC control inputs (as well as 4…20 mA using a load resistor) factory set or field selectable, floating/tri-state, two-position/on-off control. Actuators shall have visual position indicators for both standard mount and short-shaft mounting requirements.
6. All proportional actuators shall include a direct and reverse acting switch, to allow for easy adjustment of control direction of rotation. This switch must be concealed to protect it from damage and to avoid incorrect adjustment.

7. Actuators shall have an operating temperature range of -22 deg. F to 122 deg. F.

8. Actuators shall have internal electronic overload protection to protect the actuator from damage throughout its operating range. End switches to deactivate the actuator at the end of its rotation are not acceptable.

9. For power-failure/safety applications, an internal spring-return mechanism shall be built into the actuator housing. Spring-return actuators shall be capable of both CW and CCW mounting orientation. Electronic energy storage fail-safe systems incorporating high energy capacitors are an acceptable alternative to mechanical spring return mechanisms. These fail-safe systems shall provide sufficient energy to operate the actuator under full torque load. They shall include thermal compensation to the charging system of the Gold Cap capacitors, and incorporate the capacitor in the actuator control electronics to ensure long-term and consistent maintenance of voltage stored via the capacitor. During a loss of power, the electronic fail-safe systems shall mechanically lock the damper via its gear train into the desired fail-safe position.

10. For spring return proportional actuators using a 2-10 VDC control signal, the actuator shall fail open or closed based on receiving a minimum control signal of 1 VDC or less. Upon loss of power, a non-spring-return actuator shall maintain the last control position.

11. All proportional, electronic air damper and valve actuators shall be field switch adjustable for 0…10 VDC, 2…10 VDC (or 4…20 mA using a load resistor) control input.

E. Electronic Ball Valve Actuators

1. Electronic actuators shall be UL listed under standard 873, CUL, and have a CE certification.

2. Electronic valve actuators shall be capable of coupling directly to the valve stem, shaft or ISO mounting pad. Valve body and actuator shall be pre-assembled by the manufacturer to ensure adequate torque to operate and close the valve, and to provide accurate control direction and fail-safe direction assembly according to project specifications.

3. Control valve actuator shall provide minimum torque required for full valve shutoff position.

4. All electronic actuators shall include a manual positioning feature to allow for the full rotation of the actuator, in each direction with or without electrical power applied.

5. All actuators shall be designed, developed, life cycle tested and manufactured with a high performance, brushless DC motor to offer a constant running time, independent of torque load and offer maximum product reliability and life expectancy. DC motors with brushes are not acceptable.

6. All proportional actuators shall include a direct and reverse acting switch, to allow for easy adjustment of control direction of rotation. This switch must be concealed to protect it from damage and to avoid incorrect adjustment.

7. Actuators shall have an operating temperature range of -22 deg. F to 122 deg. F.

8. Actuators shall have internal electronic overload protection to protect the actuator from damage throughout its operating range. End switches to deactivate the actuator at the end of its rotation are not acceptable.

9. For power-failure/safety applications, an internal spring-return mechanism shall be built into the actuator housing. Spring-return actuators shall be capable of both CW and CCW mounting orientation. Electronic energy storage fail-safe systems incorporating high energy capacitors are an acceptable alternative to mechanical spring return mechanisms. These fail-safe systems shall provide sufficient energy to operate the actuator under full torque load. They shall include thermal compensation to the charging system of the Gold Cap capacitors, and incorporate the capacitor in the actuator control electronics to ensure long-term and consistent maintenance of voltage stored via the capacitor. During a loss of power, the electronic fail-safe systems shall mechanically lock the damper via its gear train into the desired fail-safe position.

10. For proportional actuators using a 2-10 VDC control signal, the actuator shall fail open or closed based on receiving a minimum control signal of 1 VDC or less. Upon loss of power, a non-spring-return actuator shall maintain the last control position.
11. All proportional, electronic air damper and valve actuators shall be field switch adjustable for 0…10 VDC, 2…10 VDC (or 4…20 mA using a load resistor) control input. Position feedback, running time and the programming of the micro-processor shall be factory set to avoid the introduction of electronic noise or interference with the BAS controller or other equipment. Field programming or changing of the factory set programming of the actuators is not acceptable. Actuators shall have visual position indicators for both standard mount and short-shaft mounting requirements.

F. Pneumatic Valve Operators: Rolling-diaphragm, spring-loaded, piston type with spring range as required and start-point adjustment and positioning relay for air handling unit coil valves only. Operator shall maintain full shutoff at maximum pump differential pressure.

G. Control Valves
   1. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
   2. All control valves, including but not limited to, those provided as part of other equipment systems specified in other specification sections shall also meet all the requirements of this specification section.
   3. Pressure Independent Characterized Ball Control Valves - PICCV:
      a. The modulating control valves shall be pressure independent.
      b. The control valves shall accurately control the flow from 0 to 100% full rated flow with an equal percentage flow characteristic. The flow shall not vary more than +/- 5% due to system pressure fluctuations across the valve with a minimum of 5 PSID and maximum of 50 PSID across the valve.
      c. Provide means for pressure differential measurement either across orifice or valve to be used for flow verification.
      d. Forged or cast (for larger sizes) brass body nickel plated rated at no less than 400 PSI, chrome plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and TEFZEL characterizing disc.
      e. Combination of actuator and valve shall provide a minimum close-off pressure rating of 200 PSI.
      f. The control valve shall require no maintenance and shall not include replaceable cartridges.
      g. All actuators shall be electronically programmed by use of a handheld programming device or external computer software. Programming using actuator mounted switches or multi-turn actuators are NOT acceptable. Actuators for two-position ½"-1” pressure independent control valves shall fail in place and have a mechanical device inserted between the valve and the actuator for the adjustment of flow.
      h. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory via a single screw on a four-way DIN mounting-base.
      i. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
      j. The use of pressure independent valves piped in parallel to achieve the rated coil flow shall be permitted. Actuators shall be electronically programmed to permit sequencing the flow with a single control output point. The use of external devices to permit sequencing is NOT acceptable.
   4. Pressure Dependent Characterized Ball Control Valves – CCV (1/2" - 2"):
      a. The modulating control valves shall be pressure dependent.
      b. The control valves shall accurately control the flow from 0 to 100% full rated flow with an equal percentage flow characteristic.
      c. Forged brass body, nickel plated rated at no less than 400 PSI and 250 F, stainless steel ball and stem, female NPT union ends, Teflon PTFE seats, and EDPM seat O-rings, dual EPDM lubricated O-rings at stem and TEFZEL or stainless steel characterizing disc.
      d. Combination of actuator and valve shall provide a minimum close-off pressure rating of 200 PSI and 50 PSI differential.
      e. The control valve shall require no maintenance and shall not include replaceable cartridges.
f. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory via a single screw on a four-way DIN mounting-base.
g. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
h. The use of multiple pressure dependent valves piped in parallel to achieve the rated coil flow shall be permitted. Actuators shall be electronically programmed to permit sequencing the flow with a single control output point. The use of external devices to permit sequencing is NOT acceptable.

5. Pressure Dependent Characterized Ball Control Valves – CCV (2-1/2” - 3”):
   a. The modulating control valves shall be pressure dependent.
   b. The control valves shall accurately control the flow from 0 to 100% full rated flow with an equal percentage flow characteristic.
   c. Cast iron body, rated at no less than 175 PSI and 250 F, stainless steel ball and stem, female NPT union ends, Teflon PTFE seats, and EDPM seat 0-rings, dual EPDM lubricated O-rings at stem and stainless steel characterizing disc.
   d. Combination of actuator and valve shall provide a minimum close-off pressure rating of 100 PSI and 50 PSI differential.
   e. The control valve shall require no maintenance and shall not include replaceable cartridges.
   f. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory via a single screw on a four-way DIN mounting-base.
   g. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
   h. The use of multiple pressure dependent valves piped in parallel to achieve the rated coil flow shall be permitted. Actuators shall be electronically programmed to permit sequencing the flow with a single control output point. The use of external devices to permit sequencing is NOT acceptable.

6. Pressure Dependent Butterfly Ball Control Valves:
   a. The on/off control valves shall be pressure dependent.
   b. Ductile iron body, ANSI 125 class rated at 250 F, stainless steel disc and shaft, EDPM seats and 0-rings,
   c. Combination of actuator and valve shall provide a minimum close-off pressure rating of 200 PSI.
   d. The control valve shall require no maintenance and shall not include replaceable cartridges.
   e. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory via a single screw on a four-way DIN mounting-base.
   f. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
   g. The use of multiple pressure dependent valves piped in parallel to achieve the rated coil flow shall be permitted. Actuators shall be electronically programmed to permit sequencing the flow with a single control output point. The use of external devices to permit sequencing is NOT acceptable.

7. High Performance Segmented V-Ball Control Valves:
   a. Construction: Carbon steel body, hardened stainless steel V-notch ball and shaft, low friction bearings and a TFM 1700 ball seat. Seats and stem packing shall be field replaceable. Control valves shall be rated ANSI Class VI leakage rate, -20 F to 400 F temperature range and maximum 250 PSI allowable shutoff pressure.
   b. Valves shall be applicable for HVAC temperature control with water, steam and percentage glycol water mixes. Segmented V-notch ball valves shall have 90 degree rotation, minimum 200:1 range-ability (turn-down), with equal percentage control characteristic.
   c. Valve sizes and connections:
      1) Face to Face Dimension: ASME B16.10
      2) 1”, 1-1/2” & 2” shall be ANSI Class 150/300 multi-rated and have Universal End Connections for use with MPT or ANSI Class 150/300 wafer connections.
3) 2-1/2” and greater shall have ANSI Class 150 or 300 flanges as required by application.

d. Select valve Cv for acceptable range of control authority with least pressure drop for each application.

e. Operators shall close valves against pump shutoff head.

f. Acceptable Manufacturers:
   1) Belimo, VB V Ball series
   2) DeZurik, VPB
   3) Fisher, Vee-Ball
   4) Flow-Tek, V-Control
   5) KTM, Single V Control Ball
   6) Valve Solutions, Series V

2.23 DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide control damper products by one of the listed manufacturers:
   1. Arrow United Industries
   2. Belimo Aircontrols (USA), Incorporated
   3. Cesco Products
   5. Johnson Controls, Incorporated; Controls Group.
   6. Ruskin Manufacturing Company
   7. Siemens Building Technologies
   8. T.A.C, a division of Schneider Electric

B. Construction:
   1. Frames: Extruded aluminum hat channels, 0.125-in. minimum thickness.
   2. Blades: Extruded aluminum airfoil type, 6-inch maximum blade width.
   5. Leakage: Dampers shall be AMCA rated for Leakage Class 1A at 1 in w.g. (0.25 kPa) static pressure differential and not more than 8 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf. Standard air leakage data to be certified under the AMCA Certified Ratings Program.

C. Operating Limits:
   1. Temperature: -20 to 200 degrees F.
   2. Pressure: 6 inches w.g. differential.
   3. Velocity: Up to 4000 FM.

D. Select Parallel blade dampers for proportional service. Opposed blade dampers shall be used for two-position service.
   1. Where outdoor air streams and return air streams are mixed, utilize parallel blade dampers with dampers positioned to promote mixing of airflow streams.

E. Damper sizes will be provided as indicated on the drawings. Damper sizes may be provided differently from those shown on the drawings, if improved performance can be demonstrated with calculations.

2.24 ENCLOSURES AND WEATHER SHIELDS

A. Enclosures shall meet the following minimum requirements:
   1. Outdoors: Enclosures located outdoors shall meet NEMA 250 Type 4 requirements.
   2. Mechanical and Electrical Rooms: Enclosures shall meet NEMA 250 Type 12 requirements.
   3. All Other Locations: Enclosures shall meet NEMA 250 Type 1 requirements.
4. All panels shall be self-supporting enclosures with keyed lock.  
5. Each panel shall be UL/ETL listed and stamped.

B. Weather shields shall meet the following minimum requirements:
1. They shall prevent the sun from directly striking the sensor.
2. They shall provide sufficient ventilation so that the sensing element measures the ambient conditions of the surroundings.
3. They shall prevent rain from directly striking or dripping onto the sensor.
4. When installed near outside air intake ducts, they shall be installed such that normal outside air flow does not cause rainwater to strike the sensor.
5. They shall be unpainted aluminum or they shall be white galvanized steel aluminum or PVC.

2.25 **BACNET/IP TO MS/TP ROUTER**
1. Provide network gateway to translate between BACnet/IP to MS/TP protocol.
2. Provides Routing Between:
   a. BACnet/IP and BACnet MS/TP
   b. BACnet Ethernet and BACnet MS/TP
   c. BACnet/IP and BACnet Ethernet
   d. BACnet/IP and BACnet Ethernet and BACnet MS/TP
   e. Two BACnet/IP networks
3. Communications
   a. 10/100 Mbps Ethernet with auto-negotiation and Auto-MDIX
   b. Optically isolated MS/TP port
   c. MS/TP baud rates range from 9.6-76.8 kbps
   d. Jumper-selectable MS/TP bias and termination
4. IP Network Support
   a. Web server for commissioning and troubleshooting
   b. Communication diagnostic web page
   c. BACnet/IP Broadcast Management Device (BBMD)
   d. Foreign Device Registration (FDR)
5. Installation
   a. 24 VAC/VDC (± 10%), 47-63 Hz input voltage
   b. Din-rail mounted
6. Manufacturer: Contemporary Controls used as basis of design manufacturer.

2.26 **DOMESTIC WATER METERS**
A. Manufacturers: Subject to compliance with requirements, provide control system component products by one of the listed manufacturers:
   1. Badger Water.
B. Output: Flow meters will provide an analog electronic output signal compatible with the building automation system.
C. Accuracy: 2 percent of flow rate from 0.4 to 20 feet per second.

2.27 **CONTROL CABLE**
A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

2.28 **WIRE, CABLE, AND TRANSFORMERS**
A. Refer to Division 26 for conduits and conductors, except as noted.
B. Wire and cable shall meet the requirements of NFPA 70 and NFPA 90A.
C. Terminal blocks, which are not integral to other equipment, shall be insulated, modular, feed trough, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or enclosed sides.

D. Control wiring for binary sensors shall be 18 AWG copper and shall be rated for 300-volt service.

E. Wiring for 120-volt circuits shall be 18 AWG or thicker stranded copper and shall be rated for 600-volt service.

F. Control wiring for analog signals shall be 18 AWG, copper, single or multiple strand, twisted (minimum 50 mm lay of twist), 100% shielded pairs and shall have 300 volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation.

G. IP Network cable shall meet or exceed Category 5 cable as specified in ANSI/TIA/EIA 568-A.

H. Transformers shall be UL 1585 approved and shall be sized so that the connected load is no greater than 80% of the transformer rated capacity.

I. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

2.29 OTHER EQUIPMENT REQUIREMENTS

A. Building level controllers and unit level controllers monitoring and/or transmitting fire alarm points shall have UL 864 UOJZ listing with Underwriters Laboratories. The controls contractor shall provide a copy of the UL certificate for their controllers.

B. Controllers used for smoke control shall be UL 864 UUKL listed.

C. If the DDC system is controlling a piece of equipment that is on emergency power, the DDC panel shall be connected to the same source of emergency power.

D. DDC primary LAN controllers, PCs and communication equipment that monitor life safety and critical points (such as fire alarm and elevator emergency) shall be connected to emergency power and have an online four-hour uninterruptible power supply (UPS) with full-load rectification and inversion (double conversion).

2.30 HVAC CONTROL HARDWARE IDENTIFICATION

A. Automatic Control Valve Tags: Include
   1. Lubrication instructions.
   2. Identifying number and system.

B. Wire Tags: All multi-conductor cables in all pull boxes and terminal strip cabinets shall be tagged.

C. Conduit Tags: Provide tagging or labeling of all conduits so that it is readily observable which conduit was installed or used in implementation of this work.

D. Panels and Control Devices
   1. Control Panels (Enclosures) shall be labeled.
   2. All sensors, controllers, and controlled devices shall also be labeled. (Exclude space temperature sensors)
   3. Where physical space permits, the labels shall be made of black laminoid sheet with white lettering. They shall be affixed to the panel or device by screws if possible or glue if screws are not feasible. If physical space does not permit the use of labels with readable text, tags shall be used.
   4. Identification on the labels and tags will match the identification indicated on the as-built documents.

E. Flush-mounted sensors shall be provided with label indicating function. Label shall be reviewed and coordinated with architecture for final appearance.
F. Refer to Division 23 Section Identification for HVAC Piping and Equipment for identification materials and additional requirements.

G. All identification shall be reviewed and approved with University prior to installation.

2.31 COMPRESSED AIR SUPPLY

A. Controls contractor shall provide performance based design of pneumatic air compressor (PAC-1) and associated compressed air supply piping to serve new air handling unit pneumatic actuators.

B. Manufacturers
   1. Champion
   2. Drainview Products.
   3. Pneu-line Controls.

C. Control and Instrumentation Tubing: Copper tubing complying with ASTM B 88, Type K or ASTM B 280 Type ACR.
   1. Fittings: Cast-bronze solder fittings complying with ASME B16.18; or wrought-copper solder fittings complying with ASME B16.22, except forged-brass compression-type fittings at connections to equipment.
   2. Joining Method: Soldered or brazed.

D. Tank: ASME storage tank with drain test cock, automatic moisture removal trap, tank relief valve, and rubber-cork vibration isolation mounting pads.

E. Duplex Air Compressor: Capacity to supply compressed air to temperature-control system.
   1. Pressure control with adjustable electric contacts, set to start and stop both compressors at different pressures.
   2. Electrical alternation set with motor starters and disconnect to operate compressors alternately or on time schedule.

F. Compressor Type: Reciprocating.

G. Size compressor and tank to operate compressor not more than 20 minutes during a 60-minute period.

H. Compressor Accessories: Low-resistance intake-air filter, and belt guards.

I. System Accessories: Air filter rated for 97 percent efficiency at rated airflow, and combination filter/pressure-reducing station or separate filter and pressure-reducing station.

J. Refrigerated Air Dryer: Self-contained, refrigerated air dryer complete with heat exchangers, moisture separator, internal wiring and piping, and with manual bypass valve.
   2. Refrigeration Unit: Hermetically sealed, operating to maintain dew point of 13 deg F at 20 psig, housed in steel cabinet with access door and panel.
   3. Accessories: Air-inlet temperature gage, air-inlet pressure gage, on-off switch, high-temperature light, power-on light, refrigerant gage on back, air-outlet temperature gage, air-outlet pressure gage, and with contacts for remote indication of power status and high-temperature alarm.

K. Pressure Gages: Black letters on white background, 2-1/2-inches in diameter, flush or surface mounting, with front calibration screw to match sensor, and having a graduated scale in psig.

L. Instrument Pressure Gages: Black letters on white background, 1-1/2 inches in diameter, stem mounted, with suitable dial range.

M. Diaphragm Control and Instrument Valves: 1/4-inch forged-brass body with reinforced polytetrafluoroethylene diaphragm, stainless-steel spring, and color-coded phenolic handle.
N. Gage Cocks: Tee or level handle, bronze, rated for 125 psig.

O. Relays: For summing, reversing, and amplifying highest or lowest pressure selection; with adjustable I/O ratio.

P. Switches: With indicating plates and accessible adjustment; calibrated and marked.

Q. Pressure Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure buildup, and producing flat reduced-pressure curve.

R. Particle Filters: Zinc or aluminum castings with 97 percent filtration efficiency at rated airflow, quick-disconnect service devices, and aluminum or plastic bowl with metal guard and manual drain cock.

S. Combination Filter/Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure buildup, and producing flat reduced-pressure curve; with threaded pipe connections, quick-disconnect service devices, and aluminum or plastic bowl with metal guard and manual drain cock.

T. Airborne Oil Filter: Filtration efficiency of 99.9 percent for airborne lubricating oil particles of 0.025 micron or larger.

U. Pressure Relief Valves: ASME rated and labeled.
   1. High Pressure: Size for installed capacity.
   2. Low Pressure: Size for installed capacity of pressure regulators and set at 20 percent above low pressure.

V. Pressure-Reducing Stations: Two parallel pressure regulators.

**PART 3 EXECUTION**

3.1 EXAMINATION

A. Verify that conditioned emergency power supply is available to control units and operator workstation.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install all control components in accordance with manufacturer's instructions and recommendations:
   1. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide nameplates for instruments and controls inside cabinet and nameplates on cabinet face.
   2. Install equipment, piping, wiring/conduit parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
   3. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
   4. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
   5. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

B. Graphical User Interface PC Location

   1. Install Graphical User Interface desktop/laptop computer in the building managers office. Do not deliver the Graphical User Interface PC to the job site until a proper location has been prepared. Location shall be clean and dry, free from construction dust and debris.
   2. Location shall have a dedicated work surface (table or desk with chair). Work surface shall be provided by Owner or General Contractor for use by this Contractor.
3. Location shall have ample storage provisions for documentation and manuals, either shelving or a four drawer upright filing cabinet. Storage provisions shall be provided by Owner or General Contractor for use by this Contractor.

4. Location shall have a dedicated locked electrical circuit for use by this Contractor.

C. Ethernet Network Connection

1. All devices that require a connection to the LAN or access to an ISP shall be approved by the Owners Information Technology representative prior to installation.

2. All Ethernet communication connections shall be provided by the Owner.

3. COORDINATION

A. Site:

1. The contractor shall assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will possibly interfere with work of other trades. If installation with coordination causes interference with work of other trades, the contractor shall correct conditions without extra charge.
   a. Coordinate and schedule work with work in the same area and with work that is dependent upon other work to facilitate mutual progress.

B. Submittals: See Part 1.

C. Test and Balance

1. The contractor shall provide the Test and Balance Contractor a single set of necessary tools to interface with the control system for testing and balancing.

2. The contractor shall provide a minimum of 8 hours of training on the use of the interface tools.

3. The contractor shall provide a qualified technician to assist with the testing and balancing of one system controlled by a programmable controller and the first twenty terminal units.

4. The Test and Balance contractor is obligated to return the interface tools undamaged and in working condition at completion of the testing and balancing.

D. Network

1. The contractor shall allocate space in each Building Controller control panel for the installation of a network switch. The size of the network switch shall be selected such that a minimum of one spare port is available at each control panel at the completion of the project.

E. Life Safety

1. Duct smoke detectors required for air handler shutdown are provided under Division 28. The contractor shall interlock the smoke detectors to the air handlers for shutdown.

2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 23. The contractor shall interlock the smoke dampers to the air handlers as required by the sequence of control.

F. Coordination with other controls specified in other sections or divisions: Other sections and/or division of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. The contractor shall coordinate his integration of these devices as follows.

1. Each supplier of a controls product is responsible for the configuration, programming, start-up and testing of that product to meet the sequence of control.

2. The contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.

3. The contractor is responsible for providing all controls described in the Contract Documents regardless of where within the Contract Documents these controls are described.

4. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the Contract Documents.

G. Site Meetings
1. The project manager shall attend a weekly site coordination meeting that will be attended by all of the contractors involved in the project.
2. The contractor shall allocate at least 2 hours for this meeting.

3.4 INSTALLATION

A. Temperature control panels and enclosures in equipment rooms will be located at readily accessible walkup locations approved by the owner.
B. Install equipment level and plumb. Conduits and raceways shall be parallel to walls and structural elements.
C. Install equipment in readily accessible locations as defined by Chapter 1, Article 100, and Part A of the Nations Electrical Code (NEC).
D. Install software in control units and operator workstations. Implement all features of programs to specified requirements and as appropriate to sequence of operation.
E. Connect and configure equipment and software to achieve sequence of operation specified.
F. Mount compressor and tank unit on restrained spring isolators with 1-inch static deflection. Isolate air supply with wire-braid-reinforced rubber hose. Secure and anchor according to manufacturer's written instructions and seismic-control requirements.
   1. Pipe manual and automatic drains to nearest floor drain.
   2. Supply instrument air from compressor units through filter, pressure-reducing valve, and pressure relief valve, with pressure gages and shutoff and bypass valves.
G. Verify location of temperature sensors, humidity sensors, thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.
   1. Where wall mounted sensors are mounted adjacent to light switches or occupancy sensors, install sensors to match the mounting height of the lighting control devices.
   2. Where wall mounted sensors are NOT mounted adjacent to lighting control devices, mount at same mounting height as lighting control devices.
   3. Where CO2 sensors and Humidity sensors are located with temperature sensors, it is acceptable to mount CO2 sensors and humidity sensors directly above temperature sensor and centered, with each device a few inches above the one below. Confirm arrangement before installation.
   4. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
H. Install low limit (freeze protection) thermostats on the upstream face of cooling coils in a crossing or zigzag pattern to provide freeze protection for each square foot of coil surface.
I. Provide a dedicated “unitary controller” for each air handling unit. The controller shall be mounted on the air handling unit or as indicated on the drawings.
J. Install a minimum of one “unitary controller” in each mechanical equipment room.
K. Connect manual reset limit controls, such as low limit thermostats, and high limit pressure controls, directly (hard-wired) to motor-starters (or variable speed drives). Connect limit controls to stop the fans or pumps in both the “Hand” and the “Auto” selector switch positions.
L. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
M. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
N. Install fan inlet air flow measuring stations according to the manufacturer's instructions.
O. Install duct mounted air flow measuring stations according to the manufacturer's instructions. Comply with manufactures mounting requirements to achieve specified instrument accuracy.
P. Install outside air static pressure probe according to the manufactures instructions.
Q. Connect end switches on smoke and combination fire/smoke dampers to BAS.
R. Install low voltage cabling according to Division 27 Section "Communications Horizontal Cabling."

3.5 ACTUATORS
A. Mount control damper actuators according to manufacturer's instructions.
B. When spring return actuators are used on normally closed dampers, the seals shall be compressed when the dampers have been closed by the actuator.
C. Damper/actuator combinations shall modulate smoothly from fully closed to fully open and return.
D. Actuator Selection
   1. Actuators for air handling unit coils shall be pneumatically driven with digital controls.
   2. Size damper actuators to operate the related control damper(s) with sufficient reserve power to provide smooth modulating action or two-position action.
   3. Actuators shall also be sized for proper speed of response at the velocity and pressure conditions to which the control damper is subject.
   4. Shall produce sufficient torque to close off against the maximum system pressures encountered.
   5. Shall produce sufficient torque to close off against the fan shutoff pressure as a minimum.
   6. The total damper area operated by an actuator shall not exceed 80% of the manufacturer's maximum area rating. Provide at least one actuator for each damper section. Each damper actuator shall not power more than 20 square feet of damper area.
   7. Use line shafting or shaft couplings (jack shafting) in lieu of blade-to-blade linkages or shaft coupling when driving axially aligned damper sections.

3.6 PNEUMATIC PIPING INSTALLATION
A. Provide hard-drawn copper tubing with soldered or brazed joints and tool-made bends.
B. Install piping in mechanical equipment rooms inside mechanical equipment enclosures, in pipe chases, or suspended ceilings with easy access.
   1. Install copper tubing with maximum unsupported length of 36 inches, for tubing exposed to view.
   2. Install polyethylene tubing in metallic raceways or electrical metallic tubing. Electrical metallic tubing materials and installation requirements are specified in Division 16.
C. Piping Exposed to view or Inaccessible: Provide hard-drawn copper tubing with soldered or brazed joints and tool-made bends. Or run polyethylene tubing within rigid enclosures, such as metallic raceways, EMT, or pipe where exposed to view. Or where subject to physical damage such as in mechanical equipment rooms.
D. Piping Accessible and Concealed: Provide copper or polyethylene tubing where accessible and concealed, such as within instrument panels or above suspended ceilings with easy access. Such tubing shall be run neatly, bundled, and sheathed, with a maximum unsupported length of 36 inches.
E. Terminal single-line connections less than 18 inches in length may be copper tubing, or polyethylene tubing run inside flexible steel protection.
F. In concrete slabs, furred walls, or ceilings with no access, install copper or polyethylene tubing in electrical metallic tubing or vinyl-jacketed polyethylene tubing.
   1. Protect embedded-copper and vinyl-jacketed polyethylene tubing with electrical metallic tubing extending 6 inches above finished slab and 6 inches into slab. Pressure test tubing before and after pour for leak and pinch.
   2. Install polyethylene tubing in electrical metallic tubing extending 6 inches above floor line; pull tubing into electrical metallic tubing after pour.
G. Purge tubing with dry, oil-free compressed air before connecting control instruments.
1. Bridge cabinets and doors with flexible connections fastened along hinge side; protect against abrasion. Tie and support tubing.

H. Number-code or color-code control air piping for future identification and service of control system, except local individual room control tubing.

I. Pressure Gages or Test Plugs: Install on branch lines at each receiver controller and on signal lines at each transmitter, except individual room controllers.

J. Pressure Test control air piping at 30 psi for 24 hours. Test fails if more than 5-psi loss occurs.

3.7 IDENTIFICATION

A. All identification shall be reviewed and approved with University prior to installation.

B. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

C. Enclosures: Building controllers and/or enclosures shall be clearly labeled with their device ID and IP address.

D. Unit level controllers and/or enclosures shall be clearly labeled with their Node address. Tag wiring on the DDC side of the interface panel identifying the associated point.

E. Mark DDC panels with circuit number and electrical panel number.

F. Identification of Hardware and Wiring

1. Label wiring and cable, including that within factory-fabricated panels, at each end and within 2 inches of the end of the cable with the DDC address or termination number.

2. Label pneumatic tubing at each end within 2 inches of the end with a descriptive identifier.

3. Label all control panels with minimum ½ inch letters on laminated plastic nameplates.

4. Identify all other control components with permanent labels. Plug-in components shall be labeled on both the removable component and the permanently installed base such that it is obvious where the removed component is to be re-installed.

5. Label room sensors relating to terminal box or valves with nameplates.

6. Manufacturer’s nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

7. Identifiers shall match the as-built documents.

G. Warning Labels

1. Affix permanent warning labels to equipment that can be automatically started by the DDC system.

   a. Labels shall use white lettering, 12 point type or larger, on a red background.

   b. The labels shall read: “CAUTION: This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to the OFF position before servicing.”

2. Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.

   a. Labels shall use white lettering, 12 point type or larger, on a red background.

   b. The labels shall read: “CAUTION: This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.”

3.8 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Comply with all Division 26 Installation Requirements.

B. Wiring below 8’ above finished floor shall be mechanically protected. Wiring above 8’ above finished floor may share cable tray or be supported by properly spaced supporting devices.

C. Refer to Mechanical Electrical Coordination Schedules for additional details on electrical information, disconnects, starters, controls, devices, interlocks and accessories.
D. Provide low voltage interlock wiring between supply and exhaust fans, electrical wiring for relays for temperature and pressure indication.

E. Provide wiring, conduit and connections for low temperature thermostats, high temperature thermostats, alarms, flow switches, actuating devices for temperature, humidity, pressure and flow indication, point resets and user disconnect switches for electric heating, appliances controlled by this Section.

F. Provide all other wiring required for the complete operation of the specified systems.

G. Where required install all wiring raceway systems complying with the requirements of the National Electrical Code. All required conduit shall be installed in EMT.

H. Provide electrical disconnecting means for servicing, for each control panel, digital controller, transformer, power supply, and other devices that are served by 120VAC or higher voltage.

I. Enclosures shall be fabricated of 14ga. steel with sub-panels for component mounting and have removable, hinged doors. Enclosures shall be sized to house the controllers, power supplies, transformers, wire duct and miscellaneous equipment required to support the application. Enclosures shall be provided for all controllers that are not located within an OEM provided mechanical equipment or on a VAV box. Control panels shall be fabricated as UL-508A listed assemblies.

J. Input/Output Control Wiring
1. Platinum 1k ohms and 10k ohms thermistor type II wiring shall be, stranded, twisted pair, shielded, minimum number 18 wire gauge.
2. Other analog inputs shall be a minimum of number 18 wire gauge, stranded, twisted pair.
3. Digital inputs shall be a minimum of number 18 wire gauge, stranded, twisted pair.
4. Analog outputs shall be a minimum of number 18 wire gauge, stranded, twisted pair.
5. Digital outputs shall be a minimum of number 18 wire gauge, stranded, twisted pair.

K. All input and output wiring between controllers and field devices shall be splice-free.

L. Conduit and Fittings
1. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.
2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.
3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.
4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.
5. Install low voltage power and LON and LAN communication trunks in conduit in the following locations regardless of local building code allowances otherwise.
   a. Mechanical rooms.
   b. Electrical rooms.
   c. Vertical risers (exception: fire rated continuous closet like a telephone closet).
   d. Open Areas where the wiring will be exposed to view or tampering.
6. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.

M. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:
1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.
N. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

O. Where Class 2 wiring is run exposed, wiring to be run parallel along a surface or perpendicular to it, and NEATLY tied at 3m (10 ft.) intervals.

P. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

Q. Plug or cap all unused conduit openings and stub-ups. Do not use caulking compound.

R. Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.

S. Set conduits as follows:
   1. Expanding silicone fire stop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.
   2. Oakum and lead, sealed watertight penetration through outside foundation walls.

T. Cap open ends of conduits until conductors are installed.

U. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18 inches and maximum length of 36 inches shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

V. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

W. Provide floor, wall, and ceiling plates for all conduits passing through walls, floors or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

### 3.9 ALARMS

A. The completed system must be capable of transmitting fire alarms, emergency signals and building control points. A panel failure alarm must be transmitted to the third party BACnet system when a DDC controller or network fails. Alarm conditions shall be printed and stored in an electronic text format for immediate and future reference.

B. Binary alarm points shall be Normally Open contacts (closed contact mean alarm).

C. The system shall recognize alarm point limits and alarm point lockouts from field panels for Dynamic Alarm Synchronization. Control sequences that are seasonal in operation or have alarm limits controlled based on control logic, the alarm reporting will be automatically overridden when the equipment is shut off and the alarm condition will read normal if the limits are within the alarm range.

D. Alarms will be routed to a BACnet notification class capable of routing BACnet alarms to a third party BACnet device. Applicable alarmed points will be set to BACnet intrinsic. Proprietary alarming methods requiring use of vendor specific software to view alarms are prohibited. Alarmable points will be routed to the proper CENTRAL FACILITIES HEAD.

### 3.10 FIRE ALARM MONITORING

A. Fire alarm inputs shall be configured as normally closed (open contact indicates an alarm condition).

B. The DDC system shall accept up to four normally closed binary inputs (Alarm, Water Flow, Supervisory, and Trouble).
C. DDC devices and networking equipment that monitor and/or transmit fire alarm points shall be connected to emergency power.

D. Provide (UPS) uninterruptible power supplies for DDC and networking devices that monitor and/or transmit fire alarm points that are not connected to power circuits connected to emergency generator. Refer to electrical plans and EM800 for available emergency power circuits.

E. Where UPS is required, monitor uninterruptible power supplies (UPS) required under this section and report an alarm to CENTRAL FACILITIES HEAD END whenever the UPS senses a loss of primary power or indicates a fault of any kind.

3.11 SENSORS

A. The contractor shall install sensors in accordance with the manufacturer’s recommendations.

B. The contractor shall mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Temperature sensor assemblies shall be readily accessible and adaptable to each type of application in such manner as to allow for quick, easy replacement and servicing without special tools or skills.

D. Strap-on mountings shall not be permitted.

E. Outdoor installations shall be of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects.

F. Sensors shall be within enclosures where located in finished space.

G. Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces or positions obstructed by ducts, equipment, and so forth. Locations where installed shall be within the vibration and velocity limit of the sensing element. Ducts shall be securely sealed where elements or connections penetrate ducts to avoid measuring false conditions.

H. All sensors measuring temperatures in pipes larger than 2 inches in diameter or in pressure vessels shall be supplied with wells properly fabricated for the service. Wells shall be noncorrosive to the medium being measured and shall have sufficient physical strength to withstand pressures and velocities to which they are subjected. Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to effect proper flow across the entire area of the well.

I. All field sensors, transmitters, actuators, switches, etc. shall be field calibrated. The calibration shall be guaranteed for the period of the control system warranty. Any corrections or re-calibration required during the warranty will be performed at no cost to Owner. Calibration methods, means, instruments, and standards shall be in strict accordance with ISO-9000 standards.

J. Wall mounted temperature sensors, thermostats, humidity sensors, and carbon dioxide sensors shall require elevation and location to be confirmed by architect. Devices shall be in alignment with adjacent devices.

K. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
   1. Where temperature sensors are located on exterior walls, the contractor shall completely insulate the concealed junction box. Insulation shall not impact sensor performance and shall not cause sensor to extend from wall.

L. All wires attached to sensors shall be air sealed in their raceways or in the wall to prevent air transmitted from other areas from affecting sensor readings.

M. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
N. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across the duct. Each bend shall be supported with a capillary clip. Provide 1 foot of sensing element for each square foot of coil area.

O. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in the thermal wells.

P. Install outdoor air temperature sensors on the north wall, complete with a sun shield at the designated location.

Q. Differential air static pressure sensors:
   1. For supply duct static pressure, pipe the high pressure tap to a duct probe that measures at a 90 degree angle to flow (to measure only the static pressure and not the effects of velocity). Pipe the low-pressure port to the plenum.
   2. For return duct static pressure, pipe the low pressure tap to a duct probe that measures at a 90 degree angle to flow (to measure only the static pressure and not the effects of velocity). Pipe the high-pressure port to the plenum.
   3. For zone static pressure control, pipe the ports to the locations shown on floor plans. Ports and sensors shall be hidden from view as much as possible.
   4. For building static pressure, pipe the low-pressure port of the sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.

R. Coordinate drain pan water sensor locations prior to installation. Install per manufacturer’s recommendations and adjust sensor probe and level for proper moisture detection. Conceal associated wiring.

S. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.

T. Mount transducers in a location accessible for service without the use of ladders or special equipment to the maximum extent possible.

U. All water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

V. Annular pitot tubes shall be installed so that the total head pressure ports are set-in-line with the pipe axis upstream and the static port facing downstream. The total head pressure ports shall extend diametrically across the entire pipe. Annular pitot tubes shall not be used where the flow is pulsating or where pipe vibration exists.

3.12 FLOW SWITCHES

A. Airflow Switches
   1. Install in horizontal duct runs whenever possible.
   2. If a vertical duct run is the only option, then install in a location with an upward airflow.

B. Hydronic Switches
   1. Use the correct paddle type for the pipe diameter as described by the switch manufacturer and per equipment being monitored.
   2. Adjust the flow switch in accordance with the manufacturer’s instructions.

3.13 CONTROL VALVES, CONTROL DAMPERS AND ACTUATORS

A. Control Valves:
   1. Install in an accessible location, with room for actuator removal and service. Adjust the actuator to provide tight shutoff. Provide valve stem indicator and adjust to indicate proper travel.
   2. Where butterfly valves are used, permanently mark the end of the valve shaft to indicate the valve position.
3. Coordinate with the Mechanical contractor and verify that each control valve can be serviced, including adjustment and removal of the actuator.

4. All control valves shall have unions installed at each inlet and outlet to permit removal of the valve for servicing.

5. Valve Orientation:
   a. Where possible, install valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
   b. Install valves in a position to allow full stem movement.
   c. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.

6. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

7. Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing manual throttling valve in bypass pipe.

8. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold and for each control valve larger than NPS 4.

9. Install pressure temperature taps in piping upstream and downstream of each control valve larger than NPS 2.

10. Clearance:
    a. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
    b. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.

11. Threaded Valves:
    a. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
    b. Align threads at point of assembly.
    c. Apply thread compound to external pipe threads, except where dry seal threading is specified.
    d. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

12. Flanged Valves:
    a. Align flange surfaces parallel.
    b. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

B. Control Dampers:

1. Install dampers in accordance with the manufacturer’s instructions to operate and to obtain leakage rates specified herein. Adjust the damper linkage such that the damper closes before the actuator is fully closed to assure tight shut-off of the damper.

2. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

3. Clearance:
   a. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
   b. Install dampers with at least 24 inches (600 mm) of clear space on sides of dampers requiring service access.

4. Service Access:
   a. Dampers and actuators shall be accessible for visual inspection and service.
   b. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 233300 "Air Duct Accessories."
5. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.

6. Install control dampers at inlet of roof or wall mounted exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

7. Duct openings shall be free of any obstruction or irregularities that interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure 1/4" larger than damper dimensions and shall be square, straight, and level.

8. Multiple damper sections will be square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be equal ±1/8-inches.

9. Install extended shaft or jackshaft per manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)

10. Damper blades, axles, and linkage shall operate without binding. Before system operation, cycle damper after installation to assure proper operation. On multiple section assemblies, all sections must open and close simultaneously.

11. Provide a visible and accessible indication of damper position on the drive shaft end.

12. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

13. Blank-off and seal around dampers and between dampers and sleeves or frames to eliminate air by-pass.

14. For outdoor air damper assemblies, stage the opening of each section to prevent stratification and poor mixing of outside and return air.

15. Coordinate with the Mechanical contractor the service access requirements of the control dampers, and verify that each control damper can be serviced, including adjustment and removal of the actuator.

16. Furnish interconnecting hardware, linkages, etc. for installation of multiple section dampers by Mechanical Contractor.

C. Control Valve Selection

1. Sizes used in determining valve type shall not be line size but valve size based on pressure drop and CV.

2. Air Terminal Unit Valves
   a. CCV pressure dependent characterized control valves
   b. Normal Position: Normally closed (NC)
   c. Fail Position: Fail-in-place (FIP)

3. Air Handling Unit Valves
   a. Chilled Water
      1) PICCV series pressure independent characterized control valves
      2) Fail Position: Fail-in-place (FIP)
   b. Heating Hot Water - Preheat Position
      1) (1/2"-3") CCV pressure dependent characterized control valves and (>4") butterfly pressure dependent control valves
      2) Fail Position: Spring return fail open
   c. Heating Hot Water – Heating / Reheat Position
      1) (1/2"-3") CCV pressure dependent characterized control valves and (>4") butterfly pressure dependent control valves
      2) Fail Position: Fail-in-place (FIP)

4. Chiller and Boiler Valves
   a. Control Valves
      1) (1/2"-3") CCV pressure dependent characterized control valves and (>4") butterfly pressure dependent control valves
      2) Fail Position: Spring return fail open
5. Select valve CV for 3.0 psi pressure differential with the following expect that the Cv shall be a minimum of 1.2 such that the characterizing disc opening shall not be too small and raise the potential for flow restriction or total blockage of valve. 5-psig maximum pressure drop at design flow rate is allowed to improve selection.

6. Valves sizes shall be no less than 2 nominal sizes of the installed pipe size.

7. Two-position valves shall be line size.

8. Pressure Independent Control Valve Selection Commentary
   a. There are three criteria to consider when selecting Pressure Independent Control Valves:
      1) The brass valve body maximum flow rate
      2) The programmed flow rate of the actuator.
      3) The piping package with unions should be selected with all valve installations, this guarantees the correct number and locations of test ports to properly assess valve operation.
   b. While the programmed flow rate of the actuator can be modified up to the brass valve body peak flow rate utilizing either the electronic "tool" or a cable and software, the valve body maximum flow rate is set, and cannot be altered.
   c. The actuator flow rate, set from the factory allows the valve only to modulate over the preset maximum flow range. Therefore, a 10V signal from the control system will not cause the valve to open 100%, it will open to the designated position that results in the maximum program flow.
   d. Therefore, do not select specific valve model numbers down to 1/2 gpm, but select valves based on the maximum flow rate of the valve assemblies, with an allowance for flow rates near that maximum.

3.14 INSTALLATION OF AIRFLOW MEASUREMENT DEVICES

A. Installation
   1. Install in accordance with manufacturer’s placement instructions for optimum performance at the locations indicated on the plans. A written report shall be submitted to the engineer if any discrepancies are found.

B. Adjusting
   1. Fan inlet mounted devices may be adjusted during start up and commissioning only after having been checked against known volumetric values (or against another like device measuring the same air volume) at two or more points of operations.
   2. The manufacturer’s authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer prior to installation if any measurement locations do not meet the manufacturer’s placement requirements.
   3. Field Installation: Install in accordance with manufacturer’s placement instructions for optimum performance at the locations indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.
   4. Adjustment: Duct and plenum devices shall not be adjusted without approval from the engineer. Fan inlet mounted devices may be adjusted during start up and commissioning only after having been checked against known volumetric values (or against another like device measuring the same air volume) at two or more points of operation.
   5. Calibration of Terminal Units: The controls contractor shall cooperate with the TAB Contractor for completing the calibration of VAVs, etc.

3.15 ACCESS DOORS

A. Mechanical Contractor shall provide access doors or other approved means of access through ducts for service to control equipment.
3.16 SOFTWARE AND GRAPHICS
A. Update DDC controllers to the latest released version of firmware at the completion of the project. Identical controllers will have the same software revision number when the project is complete.

B. Program schedules, parameters, high/low limits, control strategies, alarm values, descriptor, engineering units, map physical and software points into the DDC panels/work-stations or third party BACnet system.

C. The DDC operator interface will include software programming required to add the new building DDC databases and graphics to the existing University DDC network. The programmer for the DDC system will map physical and software points necessary for the operator to monitor and command physical points and adjust set points from the operator’s workstation without requiring any additional program modifications. Verify and remove points from the database that are not used in the program. The contractor will be responsible for point mapping and input/output object creation. A minimum of eight points shall be mapped from all VAV controllers to the master workstation and/or integrated system.

D. The addition of the DDC points to the new subsystem shall not cause that subsystem or any other subsystem to stop functioning (crash) or slow down the request for point information. Subsystem start up synchronization between field panels and operator workstations and any subsystem shall not cause that subsystem or any other subsystem to stop functioning (crash) or slow down the request for point information.

E. Database programs shall be complied and/or de-compiled for errors before saving to the master front-end hard drive. Follow the specific procedures for directory, path and file names.

F. Upload all DDC controller databases, including network controller level DDC programs, to the master operator workstation front end PC located in CENTRAL FACILITIES HEAD END. Primary and secondary bus controllers, including VAV box controllers, shall be uploaded and saved separately to the building (OWS) operator’s workstation.

G. The University shall have the capability to add, modify and delete time of day schedules, holiday schedules, weekday schedules, weekend schedules, temporary schedules, etc. from the vendor’s front end.

3.17 POINT NAMING/POINT LOGICAL GROUPING AND GRAPHICS
A. The programmer shall meet with CENTRAL FACILITIES personnel before proceeding with programming to review point naming, system layout, point logical grouping, graphics, graphical display response time, and tree structure. Contact CENTRAL FACILITIES personnel before deviating from University Standards.

B. Supervisory controllers must be named with their corresponding building number & panel number. Before database generation is started, controls contractors are advised to contact Energy Management for questions regarding naming. Energy Management reserves the right to require changes to point naming if the controls contractor does not clarify naming before start of the controller database(s).

C. BACnet Object Identification numbers must also include building number and panel number. Controls contractors must coordinate Object IDs & IP address information with Energy Management prior to the start of database generation.

3.18 PROGRAMMING FOR PROGRAMMABLE DEVICES
A. These requirements apply to Building Controllers and Unit Level Controllers.

B. Process control loops for an integral system shall reside in a single controller. Examples of integral systems are:
   1. Air handling units.
C. To the maximum extent possible, process control loops for built up systems shall reside in a single controller. The objective of this requirement is to use large point count primary controllers in lieu of multiple secondary controllers.

D. Supervisory logic for integral and built up systems may reside in building controllers with the output commands to the process control loops traversing the field bus to the controllers executing the process control.

E. Create and download application programs that meet the requirements of the sequence of operations, time scheduling requirements, trend logging requirements, alarm handling requirements and data visibility requirements at the OWS.
   1. Use the University point naming convention throughout the project.
   2. Time schedules shall be fully configured with weekly schedules and holidays identified by the owner.
   3. Trend logs identified in the sequence of control shall be fully configured and operational.
   4. Alarm handling shall be consistent with University alarming standards.
   5. Application parameters identified as (adj.) in the sequence of control shall be exposed as viewable parameters and appropriate initial values shall be set.
   6. Manual control of external points shall be configured with BACnet command priority eight (8) unless otherwise specified in the sequence of control.
   7. For variables broadcast onto the field bus, event driven communication shall be used to avoid data storms. As a minimum the program shall provide for the send on delta parameter and minimum send time parameter for each output variable.
   8. Embed into the programs sufficient comment statements to clearly describe each section of the program. This applies to both line programming and graphical programming systems.
   9. If graphical programming systems with multiple layers for the functional block diagrams are used, no more than two layers shall be used.

F. Device-to-device (peer-to-peer) data flow shall be in place and configured to meet the sequence of control.

G. The programmed applications for a single integrated system shall not be distributed over more than one field bus. Example:
   1. Multiple air handling units are controlled by controllers on field bus number 1. The chiller system is controlled by controllers on field bus number 2. The chiller control logic requires the chilled water valve positions from each of the air handling unit controllers. It is acceptable that these related but non-integral systems are controlled by controllers on different field busses.

3.19 SYSTEMS INTEGRATION

A. Provide on-site and off-site programming as required to provide a fully operational integrated system. Coordinate all programming and point mapping requirements with University personnel. Provide engineering and analysis work necessary to determine the method of network connectivity. Provide program hardware, wiring, network devices, cabling, software and graphics to connect the new DDC controls system to the University DDC network. The interface will allow, at a minimum, the following:
   1. Alarm annunciation in CENTRAL FACILITIES HEAD END
   2. Output control
   3. Analog and digital commands
   4. Reset commands
   5. Point enable and disable
   6. Set point adjustments
   7. Time of Day Scheduling
   8. Dynamic Alarm Synchronization
3.20 CYBERSECURITY RISK MITIGATION STRATEGY

A. Security levels and password access shall be incorporated in accordance with University’s FP&M requirements. Contractors will set-up an unrestricted WSU specific account with a unique password (Cautioned FP&M because C&IT requirements are different)

B. Coordinate with Owner’s IT Department to restrict external network access to Internet connected system through virtual private network (VPN) connections only.

C. All external transport data shall be routed through encrypted channels with 2048-bit secure sockets layer (SSL).

D. Coordinate with Owner’s IT Department to implement a Web server-based human machine interface (HMI) that relies on IT technologies to secure access and restrict ports that can be opened on the firewall. Coordinate with Owner’s IT Department to restrict access to known IP addresses only.

E. Where building system networks are not physically separate from IT business networks, coordinate with Owner’s IT Department to segregate networked and Internet connected systems from the IT business network using virtual local area network (VLAN) IT technologies to restrict internal attacks/breakdowns.

F. Set unique, cryptographically strong passwords for administrator and user accounts. Default passwords must be changed before systems are connected to the Owner’s network.

G. Collect only the data that is necessary for analytics and optimization.

H. References: As a minimum, adhere to practices described in the following network and cybersecurity standards documents:
   1. NIST Special Publication 800-14 – Generally Accepted Principles and Practices for Securing Information Technology Systems
   2. NIST Special Publication 800-54 Revisions 4 – Security and Privacy Controls for Federal Information Systems and Organizations

3.21 IP INTERFACE DEVICES

A. Install Building Controllers for each required connection to the dedicated DDC TCP/IP network.

B. The Building Controllers shall be configured and commissioned to ensure that the only data traffic on the TCP/IP is data that is essential for operation of the system. Messages between field devices on the same field bus shall not be allowed to pass onto the TCP/IP network.

3.22 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   2. Test and adjust controls and safeties.
   3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
   4. Test each point through its full operating range to verify that safety and operating control setpoints are as required.
   5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
   6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:
   1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
   2. Check instruments for proper location and accessibility.
   3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
   4. Check temperature instruments and material and length of sensing elements.
   5. Check control valves. Verify that they are in correct direction.
   6. Check DDC system as follows:
      a. Verify that DDC controller power supply is from emergency power supply, if applicable.
      b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
      c. Verify that spare I/O capacity has been provided.
      d. Verify that DDC controllers are protected from power supply surges.
   7. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
   8. Verify operation of operator workstation.
   9. Verify local control units including self-diagnostics.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.23 ADJUSTING

A. Calibrating and Adjusting:
   1. Calibrate instruments.
   2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
   4. Control System Inputs and Outputs:
      a. Check analog inputs at 0, 50, and 100 percent of span.
      b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
      c. Check digital inputs using jumper wire.
      d. Check digital outputs using ohmmeter to test for contact making or breaking.
      e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
   5. Flow:
      a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
      b. Manually operate flow switches to verify that they make or break contact.
   6. Pressure:
      a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
      b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
   7. Temperature:
      a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
      b. Calibrate temperature switches to make or break contacts.
   8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
   9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.24 CONTROL SYSTEM CHECKOUT

A. Provide apparatus required to execute the start up testing plan. Key tasks to be executed and documented in the start up testing report include:

1. Verification of primary and secondary voltages.
2. Verification that power wiring for devices conforms to manufacturer’s instructions.
3. Verification that labeling is in place.
4. Inspection of wiring for loose strands and tight connections.
5. Verification of field bus topology, grounding of shields (if used) and installation of termination devices.
6. Verification that each I/O device is landed per the submittals and functions per the sequence of control.
   a. Analog sensors shall be properly scaled and a value reported to the OWS.
   b. Binary sensors shall have the specified normal position and the state is reporting properly to the OWS.
   c. Analog outputs have the specified normal position and move full stroke when so commanded.
   d. Binary outputs have the specified normal state and respond to energize/de-energize commands.
7. Analog sensors calibrated with high quality instrumentation suitable for the sensor being calibrated.
   a. The instruments shall display a current (12 month) NIST traceable calibration sticker. Associated instrument calibration certificates shall be made available within 24 hours of a request.
   b. The measured value, reported value, and the calculated offset that was entered into the database shall be recorded.
   c. Calibration criteria:
      1) Space Temperature: +/- 0.5 degrees F
      2) Air Temperature: +/- 0.5 degrees F
      3) Fluid Temperature: +/- 0.5 degrees F
      4) Air Flow Rate: +/- 5 %
      5) Liquid Flow Rate: +/- 5 %
      6) Differential Pressure: +/- 3 %
      7) Gauge Pressure: +/- 5%
      8) Relative Humidity: +/- 3 % relative humidity
      9) CO2: +/- 2 %
8. Loop Tuning
   a. Tune P, PI and PID control loops.
   b. The loop tuning criteria shall be a stable control loop where the average error over 15 minutes and 30 samples shall be less than:
      1) Space Temperature: +/- 0.75 degrees F
      2) Air Temperature: +/- 1.50 degrees F
      3) Air Humidity: +/- 5 % relative humidity
      4) Chilled Water Temp: +/- 1.00 degrees F
      5) Hot Water Temp: +/- 1.00 degrees F
      6) Duct Pressure: +/- 0.2 inches w.g.
3.25 TESTING AND COMMISSIONING

A. The HVAC and control systems will be commissioned in accordance with the project Commissioning Plan. If no Commissioning Plan has been prepared, the systems shall be commissioning in accordance with ASHRAE Guideline 1. The controls contractor shall provide assistance, staff and materials to support the commissioning activities.

B. Buildings transmitting fire alarm signals will be tested in accordance with NFPA 72; 4.5 Documentation, 4.5.1; Approval and Acceptance, sub-section 4.5.1.2, 4.5.2; Completion Documents and 4.5.3 Records. Test transmission of fire, trouble and supervisory signals. University staff and Code Officials are available for consultation and testing support.

C. Provide assistance, staff and materials to support the commissioning activities in the presence of a designated University Representative, which shall include the following tests:
   1. When installation is complete, verify and document communication transmission between each building, the vendor’s master workstation, and any third party BACnet workstation. The controls contractor is responsible for all final adjustments and testing. Submit test report to the Owners Representative as part of the final operational test.
   2. Field test the accuracy of points and verify that the vendor’s front end and third party BACnet workstation receives the change of states. Field point status must be in sync with the present alarm conditions, values, and status of points that are mapped into the third party BACnet workstation. Any device out of the specified range shall be identified in the checkout report. Field controller information for analog, digital, software points, etc, received at the integrated front end, shall not be more then 10 seconds old.
   3. Analog inputs shall be verified for accuracy according to the specifications for the device. Any device out of the specified range shall be replaced. The devices shall be tested against the calibrated instrument used in the initial setup of the device.
   4. Switch the status of digital inputs from the final field device. Verify that CENTRAL FACILITIES HEAD END received the change of state.
   5. The building control system shall provide commands to outputs. Proper operation shall be verified in the field.
   6. DDC panels shall be tested for panel alarm condition and communication trunk will be tested for panel no response alarm conditions at the vendor’s master workstation and at the MLWS.

D. Points shall be in the automatic mode when the project is turned over to the University.

E. Verification Testing.
   1. The University will perform verification tests on equipment installed as part of this project.
   2. The University will develop verification test plans for each system.
   3. The controls contractor is responsible for providing materials and labor to assist the University with verification testing. A University representative will witness verification testing.
   4. The University will compile a log of open and deficient items observed during the testing.
      a. The controls contractor shall complete required repairs, test the system, and inform the University that the open and deficient items have been resolved within one week after receipt of the log.
      b. The University will retest the corrected items to confirm they are complete. It is expected that the controls contractor will correct all deficiencies in a timely manner and that multiple retesting by University staff will not be required.

F. Test and Balance
   1. Provide the Test and Balance technician a single set of necessary tools to interface with the control system for testing and balancing.
   2. Provide a minimum of 4 hours of training on the use of the interface tools.
   3. Provide a qualified technician to assist with the testing and balancing of one system controlled by a programmable controller and the first twenty terminal units.
3.26 TRAINING

A. Engage a factory service representative to train Owner’s personnel to adjust, operate, and maintain control systems and components.
   1. Train Owner’s personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
   2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs.

B. Schedule training with Owner, through Architect, with at least seven days’ advance notice.

C. An outline of the proposed training agenda will be submitted to the University’s Facility Management team for review.

D. The manufacturer will provide training for the Owner's building personnel in procedures for start-up, testing, and operating the Automatic Control System. Instruct the Owner's personnel so that they can troubleshoot and maintain integration hardware and databases, program, reprogram, and/or reenter the desired schedules, values, settings, and strategies.

E. During the startup phase of the installation, and when acceptable performance of the overall system's hardware and software has been established. The contractor will provide on-site operator instruction for the Owner's operating personnel.

F. Operator instruction about the automatic control system will include, but not be limited to the overall operational program, equipment functions (both individually and as part of the total integrated system), commands, system generation, advisories, and appropriate operator intervention required in responding to the automatic control system operation, a description of the chronological information flow from field sensors, contacts and devices and an overview of the automatic control system communication network explaining the interplay between initiating devices, field data-gathering panels, system communications and their importance within the operating system.

G. Provide on-site operator instruction during normal working hours. Instruction will be performed by experienced factory trained technical representatives familiar with the overall system’s software, hardware and accessories. Provide a minimum of forty (40) hours of on-site training for three (3) of the Owner's designated operating personnel.

3.27 CLOSEOUT

A. The University’s Master Integrator shall review the final control system information and shall provide confirmation whether the system meets all project requirements.

B. The following are items that will be reviewed to determine whether control system meets closeout requirements:
   1. BACnet IP over controller or incorporated gateway capable of networking full system information via BACnet over IP
   2. All points open read / write – Confirmed by University’s Master Integrator
   3. Point descriptors that are understandable not indecipherable abbreviations – Confirmed by University’s Master Integrator
   4. All nomenclature on selected unit(s), equipment, and components
   5. Sequence of operation for all units
   6. System layout drawing – Fans, dampers, coils, etc.
   7. Wiring Diagram(s) both schematic (ladder) and common diagram (Ladder shows logic and common shows location of components and connections within the unit)

END OF SECTION
SECTION 230993
SEQUENCE OF OPERATION FOR HVAC CONTROLS

Issued, Bulletin 14, 03/15/2022

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
   1. Temperature, flow and pressure set points listed shall be adjustable.
   B. Related Sections include the following:
      1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

1.3 DESCRIPTION OF WORK:
   A. Control sequences are hereby defined as the manner and method by which automatic temperature controls function. Requirements for each type of operation are specified in this section.
   B. Refer to drawings for additional control system requirements.
   C. Operating equipment, devices, and system components required for control systems are specified in other Division-23 sections of these specifications.
   D. Provide all equipment, devices, and system components required to accomplish the control sequences described in this section. Equipment, devices, and system components not specified in other Division-23 sections but necessary to accomplish the sequences specified in this division shall be provided.

1.4 SUBMITTALS
   A. Shop Drawings: Submit shop drawings for each system automatically or manually controlled. Refer to specification 230900 for submittal requirements.

1.5 DEFINITIONS
   A. Alarm: An indication of a dangerous situation annunciated to the automatic control system. In addition, alarms should sound a horn to alert the operator that corrective action needs to be taken immediately.
   B. Closed: When used to describe a control valve or damper means fully closed (no flow).
   C. Control Screens: The graphical interface of the automatic control system shall have schematic diagrams of each system, and operating details of major equipment. The control set points, operating parameters noted within the following sequences shall be provided on the related screen.
   D. DDC: Direct-digital controls.
   E. Modulate: Linear infinite positioning from fully open to fully closed.
   F. Full(y) open: The term full open or fully open when used to describe variable air volume terminal units means that the terminal damper is 100% open.
G. Open: The term full open or fully open when used to describe variable air volume terminal units means that the terminal is open to the setpoint volume.

H. Temperatures: All temperatures listed are degrees Fahrenheit.

I. Set Points: All system set points will be operator adjustable unless specifically noted. All offsets and time delays shall likewise be adjustable and accessible by the operator. Some items are specifically noted as adjustable (adj.), to alert the operator that the point must be tuned from experience. This does not preclude other setpoints, offsets and time delays from being adjustable.

J. Warning: An indication of an abnormal or potential problem condition. Warnings shall be annunciated to the automatic control system.

K. VAV: Variable air volume.

L. VSD: Variable speed drive.

M. BAS/BMS: Building Automation/Management System

PART 2 PRODUCTS  
(Not applicable to this section)

PART 3 EXECUTION

3.1 GENERAL

A. Provide all necessary instrumentation to obtain setpoints, readings, etc. listing in sequence of operation.

B. Wayne State University has and existing Siemens Building Automation System (BAS) front-end which includes a web interface and centrally managed data collection server. All building monitoring shall be hardwired back to the nearest Siemens Building Automation System connection. All BAS cabinets, power monitors, and associated devices must communicate back to the campus enterprise network. Data is managed and pulled stored in 15 minutes intervals at Wayne State’s centralized Siemens’s server and then pushed to the System server via a CSV (Siemens) file transfer. All programming shall be coordinated with Wayne State University and appropriate staff.

3.2 TREND LOGS

A. Trends logs are historical archives stored in the BMS that document the operation of the systems and equipment. Trends can be interval recordings of system I/O parameters or Change of Value based trends that record when a system value changes by more than a specified threshold.

B. Sample times indicated as COV (±) or change of value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When output to the trending file, the latest recorded value shall be listed with any given time increment record.

C. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field. Recorded parameters for a given piece of equipment or component should be trended at the same intervals.

D. Trending Requirements: At a minimum, trend the following on 15 min. intervals for analog values and change of value for binary values:

<p>| Equipment ID / Trending Interval (minutes) |</p>
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<thead>
<tr>
<th>Point Description</th>
<th>Units</th>
<th>Chilled Water System</th>
<th>Heating Hot Water System</th>
<th>Air Handling System</th>
<th>Heat Recovery System</th>
<th>Boiler</th>
<th>Humidifiers</th>
<th>Air Terminal Units</th>
<th>Fin Tube Radiation</th>
<th>Fin Tube Radiator</th>
<th>Unit Heater</th>
<th>Electrical Metering</th>
<th>Domestic Water Meter</th>
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### Sequence of Operation for HVAC Controls

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<tr>
<td>Electric consumption</td>
<td>kWh</td>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

E. Trending to document functional tests may require a more frequent interval. Coordinate with the CxA to determine the correct intervals to prove operational testing and modify intervals as required.

F. The BMS contractor shall set up the trends logs, ensure they are being stored properly, and then forward the data in electronic format to the CxA. Data shall be forwarded in one of the following formats:
   a. Microsoft EXCEL Spreadsheet (.xls)
   b. Comma Separated Value (.csv or .txt) preferably with quotes delimiting text fields and # delimiting date/time fields

G. Data storage shall be provided such that trend data is archived for at least 36 months.

H. The CxA shall analyze trend logs of the system operating parameters to evaluate normal system functionality.

I. The BMS contractor shall allow the CxA BMS access to view the trend log data and allow
3.3 TREND GRAPHS

A. Trend graphs are generally used to facilitate and document testing. The BMS contractor shall prepare controller and workstation software to display graphical trends.

B. On the trend graphs, lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.

C. Indicate engineering units of the y-axis values; e.g. degrees F, inches w.g., Btu/lb, percent wide open, etc. The y-axis scale shall be set such that all trended values are in a readable range.

D. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended.

E. All points trended for one HVAC subsystem shall be trended during the same trend interval.

F. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

G. The BMS contractor shall forward the trend graphs to the CxA for review.

3.4 TIME SCHEDULE

A. HVAC equipment will be scheduled for occupied and unoccupied status.

B. The daily scheduler will allow the system operator to switch between occupied and unoccupied status a minimum of five times per day. Holidays, events and weekends will be scheduled separately.

C. The initial schedule will incorporate all equipment connected to the building automation system. Coordinate the initial scheduled occupied/unoccupied hours with the owner and incorporate the schedules before substantial completion.

3.5 AIR HANDLING UNITS: GENERAL

A. Operator Station Display: Indicate the following on operator workstation display terminal for each air handling unit:

   1. DDC system graphic
   2. DDC system on-off indication
   3. DDC system occupied/unoccupied mode
   4. Outdoor-air-temperature indication
   5. Supply-fan on-off indication
   6. Supply-fan-discharge static-pressure indication
   7. Supply-fan-discharge static-pressure set point
   8. Supply-fan airflow rate
   9. Supply-fan speed
   10. Relief-fan on-off indication
   11. Relief-air static-pressure indication
   12. Relief-air static-pressure set point
   13. Relief-fan airflow rate
   14. Relief-fan speed
   15. Building static-pressure indication
   16. Building static-pressure set point
   17. High building static-pressure alarm
   18. Low building static-pressure alarm
   19. Zone/space static-pressure indication
   20. Zone/space static-pressure set point
   21. High zone/space static-pressure alarm
   22. Low zone/space static-pressure alarm
23. Mixed-air-temperature indication
24. Mixed-air damper position
25. Return-air damper position
26. Outdoor-air damper position
27. Outdoor-air airflow rate
28. Outdoor-air damper end switch position indicator
29. Outdoor-air damper end switch position alarm
30. Space humidity indication
31. Space humidity set point
32. Space high humidity warning indication
33. Space high humidity alarm indication
34. Pre-filter air-pressure-drop indication
35. Pre-filter high-air-pressure set point
36. Pre-filter high-air-pressure warning
37. Final-Filter air-pressure-drop indication
38. Final-Filter high-air-pressure set point
39. Final-Filter high-air-pressure warning
40. Fan-discharge air-temperature indication
41. Fan-discharge air-temperature set point
42. High fan-discharge air-temperature warning
43. Low fan-discharge air-temperature warning
44. Discharge air temperature setpoint
45. Heating-coil air-temperature
46. Heating-coil control-valve position
47. Heating-coil hot water return temperature
48. Re-Heating-coil air-temperature
49. Re-Heating-coil control-valve position
50. Re-Heating-coil hot water return temperature
51. Cooling-coil air-temperature indication
52. Cooling-coil air-temperature set point
53. Cooling-coil control-valve position
54. Cooling-coil chilled water return temperature
55. Room temperature indication
56. Room temperature set point
57. High zone temperature alarm
58. Low zone temperature alarm
59. Smoke alarm
60. Temperature low limit / freezestat alarm
61. High static pressure alarm (supply, return and relief fans)
62. Low static pressure alarm (supply, return and relief fans where indicated)
63. Supply fan failure alarm
64. Supply fan in hand alarm
65. Supply fan belt failure alarm
66. Supply fan VSD fault alarm
67. Relief fan failure alarm
68. Relief fan in hand alarm
69. Relief fan belt failure alarm
70. Relief fan VSD fault alarm
71. Paint booth exhaust fan status
72. Dust collector status
73. Dust collector alarm
74. Fog haze mode status

3.6 AIR HANDLING UNIT AHU-1 CONTROL SEQUENCE

A. General
1. System is a single-zone, variable volume, variable air temperature (reset) type air-handling system which provides heating, cooling, dehumidification, fog/haze exhaust to provide space temperature control and support stage production events.

2. The units consist of supply fan(s), outside air/return air/relief air dampers, chilled water cooling coil(s), hot water heating coil(s), economizer dampers, outdoor air dampers, air filters, and return/relief fan(s).

3. The air handling system shall be controlled automatically through local direct digital control panels using PI and PID control methods. Sensing elements, damper and valve operators shall be electronic types. Safety and limit controls shall utilize local electric control loops.

4. Supply and return fans shall be interlocked via DDC to start and stop simultaneously under normal conditions.

5. In addition, signals from freezestat(s), fan differential, smoke detection, or pressure shutdown switches shall shut-down all fans including associated supply and return fans.

6. Air handling unit shall have individual setpoints, schedules, alarms, safeties, etc. unless specifically noted elsewhere.

B. Safety and Unit Protection

1. Smoke Detectors: Refer to Division 28 for smoke detector and system shut down requirements.

2. Air Handling Unit Smoke Shutdown.
   a. Signal(s) from the fire alarm system shall be extended to connection points in the supply and/or return fan variable speed drive(s) to stop the unit fans if smoke is sensed within the air handling unit and/or a smoke zone/compartment served by the AHU. Upon fire alarm signal termination, AHU operation shall return to the normal operating conditions.
   b. Smoke alarms shall be programmable to allow (with approval of the Responding Authority) them to be defeated during use of heavy stage fog effects.
   c. AHU smoke detectors and fire alarm signal wiring to the fan variable speed drives will be provided by the Fire Alarm Contractor as work of Division 28.
   d. Refer to supply and return/relief fan articles for AHU related smoke/fire damper control.
   e. Means shall be available to terminate the AHU operation (stop fan operation) from a manual reset at the BAS and/or Fire Alarm Panel.

3. Supply Fan Discharge Static Pressure High Limit.
   a. A high limit pressure control shall stop the supply fan if the static pressure at the fan discharge exceeds the setpoint. The pressure sensing element shall be located between the fan and the first automatic control or fire/smoke damper. The high limit pressure switch shall be manually reset at the Operator Workstation.
   b. A supervisory alarm on the BAS shall indicate that the fan has tripped on high limit.

4. Return Fan Static Pressure High Limit.
   a. A high limit pressure control shall stop the return fan if the static pressure at the fan inlet exceeds the setpoint. The high limit pressure switch shall be manually reset at the Operator Workstation.
   b. A supervisory alarm on the BAS shall indicate that the fan has tripped on high limit.

5. Temperature Low Limit
   a. An averaging serpentined low limit temperature sensor located downstream of the heating coil shall provide a supervisory alarm on the BAS if signal an alarm onto the BAS if the temperature falls below 38° F. Unit shall shut down on low temperature limit if the temperature downstream of the unit coil(s) is below 35° F for any 1 foot section of sensor.
   b. Temperature low limit shall be manually reset through the Operator Workstation.

6. Provide a local alarm defeating switch for each air handling system.

C. Run Conditions

1. The air handling unit shall be operated continuously according to the building operating schedule and during schedulable events such as evening and weekend performances.

2. During unoccupied periods, the system shall maintain critical space temperature setpoints and all other space temperature at an adjustable minimum unoccupied heating temperature setpoint of 66 degrees and 78 degrees unoccupied cooling setpoint.
a. Provide operator adjustable setback setpoints and warm-up and cool-down operations for the system.
b. Setback mode shall include operating a single fan at an adjustable minimum speed.
c. Provide settings for opening up air terminal units / VAV boxes to adjustable minimum positions during setback operations.
d. Provide option (selectable by the operator) for outside-air damper(s) to be fully closed during unoccupied and warm-up and cool-down operations.

3. AHU Optimal Start: The unit shall start prior to scheduled occupancy based on the time necessary for the zone(s) to reach the( ir) occupied setpoint(s). The start time shall automatically adjust based on changes in outside air and zone temperatures.

D. Off Condition.
1. When the supply fan is off, the air-handling system components shall remain in the following positions:
   a. Return fans are off.
   b. Cooling coil chilled water control valve is closed.
      1) In the event of power failure, the valve shall fail open.
   c. Heating coil control valve shall modulate to maintain temperature sensed downstream of the coil at 38º F (adjustable).
      1) In the event of power failure, the valve shall fail open.
   d. Re-Heating coil control valve valves is closed.
      1) In the event of power failure, the valve shall fail closed.
   e. Outside air dampers shall be closed.
   f. Return air damper shall be open.
   g. Relief air dampers shall be closed

E. Supply Air Volume and Temperature Control
1. Space temperature sensors shall provide a signal to proportionally adjust the unit flow rate, the chilled-water cooling coil and the hot water heating coil in sequence to provide cooling or heating to maintain the space temperature setpoint.
2. Airflow measuring stations located in each supply fan inlet shall provide airflow (CFM) monitoring and tracking of actual fan volume.
3. Supply Air Temperature Control
   a. On a call for either heating or cooling, a supply air temperature sensor (DAT) located in the supply air plenum (downstream of the supply fan) and upstream of re-heat coil shall modulate the chilled water cooling coil control valve and heating valve to maintain an adjustable supply air temperature setpoint. The supply air temperature sensor shall be an averaging capillary type sensor. Initial setpoint is 54 Deg F.
      1) The chilled water cooling coil control valve shall be a pressure independent two-way modulating valve, normally open.
      2) The heating coil control valve shall be a two-way modulating valve, normally open.
      3) Monitor hot water return temperature from coil. Alarm if hot water return temperature drops below 60 deg F (adj).
      4) Monitor chilled water return temperature from coil.
   b. Dehumidification reset control: The supply air temperature set-point shall be reset downward in .5 deg F increments to 50 Deg F to maintain maximum return air humidity set-point of 56% (adj). Reset shall temperature shall utilize PID controls. Discharge air temperature shall return to initial setpoint at start of new occupied period.
4. On a call for heating, the fan shall modulate to minimum cfm and the downstream reheating water control valve shall be proportionally positioned from fully closed to fully open to maintain the space temperature setpoint. After heating coil at full open and temperature not satisfied, sequence fan cfm from minimum position to design airflow to satisfy space temperature setpoint. Initial minimum cfm is 30% design cfm (adj).
5. On a call for cooling, the fan shall modulate to minimum cfm and the chilled water control valve shall be proportionally positioned to meet setpoints listed above from fully closed to fully open to maintain the space temperature setpoint. After cooling coil is full open and temperature not satisfied, sequence fan cfm from minimum position to design airflow to satisfy space temperature setpoint. Initial minimum cfm is 30% design cfm (adj).

6. The supply fan(s) shall be operated continuously during scheduled occupied hours to maintain scheduled airflow rate (Adj) and during unoccupied hours to maintain airflow rate setpoint (adj).

7. The supply fan shall be soft started through the variable speed drive. Normal position shall be zero rpm. Fan acceleration and deceleration rates shall be adjustable at the variable speed drive to provide stable operation and to prevent tripping of the high limit pressure control.

8. A duct static pressure sensor / transmitter(s) shall provide signal to monitor the supply air duct static pressure. Provide a second sequence of supply fan control where the duct static pressure is used to vary supply fan speed to meet zone temperature requirements. This sequence shall only be used if air flow measurement is found to be unstable and can be manually switched over by the building automation system operator.

9. Minimum alarms shall be provided as follows:
   a. Provide alarm per fan if loss of signal, VSD alarm, or individual fan airflow drops below 1000 cfm (Adj).
   b. Supply Fan Failure: Commanded on, but the status is off.
   c. Supply Fan in Hand: Commanded off, but the status is on.
   d. Supply Fan Belt Failure (if belt driven): Commanded on, status is on, but airflow is zero.
   e. Supply Fan VSD fault.

10. Minimum warnings shall be provided as follows:
   a. High supply air static pressure: If the supply air static pressure is 30% higher than setpoint
   b. Low supply air static pressure: If the supply air static pressure is 30% less than setpoint.

F. Outdoor Air / Economizer Control

1. Minimum Outside Air Damper Control
   a. Minimum outdoor air quantities are as follows:

<table>
<thead>
<tr>
<th>Unoccupied Mode</th>
<th>Demand Control Minimum Mode</th>
<th>Minimum Occupied Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHU-1</td>
<td>0 cfm (adj)</td>
<td>500 cfm</td>
</tr>
<tr>
<td></td>
<td>Refer to AHU Schedule (adj)</td>
<td></td>
</tr>
</tbody>
</table>

   b. Whenever the supply fan is started, the outside air damper shall be proportionally opened and controlled to maintain the adjustable minimum outside air quantity.

   c. Minimum ventilation control
      1) During occupied mode, the system shall provide the demand control minimum outside air CFM volume according to ASHRAE 62.1.
      2) Minimum outdoor air CFM quantity shall be the determined by one of the following:
         (a) Minimum Demand Control Mode outdoor air volume
         (b) The minimum amount of outdoor air required to meet static pressure setpoint but minimum outdoor air shall not raise above Minimum Occupied Mode outdoor air cfm.
      3) Demand Control Minimum Ventilation Control
         (a) The Demand Ventilation Controls shall first increase zone minimum airflow to satisfy ventilation requirements, and then increase the outdoor air rate at the air handler as described in the following sequence.
         (b) At any zone with CO2 sensors: Upon a rise in zone CO2 concentration above setpoint (1200 ppm initial setpoint), the minimum occupied airflow setpoint at the zone VAV terminal shall first slowly raise from the current airflow rate up to full flow until CO2 setpoint is maintained.
         (c) At the Air Handler: Upon continued call for ventilation (based on continued rise in critical zone CO2 concentration with VAV terminal at ventilation override maximum setpoint, then increase the minimum outdoor air rate (or damper position) from Demand Control minimum to Minimum occupied mode cfm.
(d) Provide warning alarm whenever any space CO2 concentrations exceed 1,300 ppm for longer than 20 minutes (adj).
(e) This function shall be operational only during minimum outside air modes.

2. Economizer Outdoor Air Control
   a. BAS shall modulate the outdoor air damper and mixed air damper to provide “free cooling” when conditions merit.
   b. While conditions merit, dampers shall be modulated in a DA PID loop to maintain mixed air temperature at a setpoint as specified for the individual unit. Economizer logic shall remain enabled during setback cooling where applicable.
   c. Dry Bulb Switch: Economizer mode shall be active while: 1) The unit is energized 2) AND, when outside air temperature falls below the switching setpoint of 63°F (adj.) (with 2°F (adj.) cycle differential - Enable at 63°F, Disable at 65°F). 3) AND, either of the following are true:
      1) Outside air temperature is less than 55°F (adj.)
      2) OR, Return (exhaust) air humidity is not greater than 55% (with 2% (adj.) cycle differential)
   d. Economizer mode shall be inactive when outside air temperature rises above switching setpoint, dampers shall return to their scheduled minimum positions as specified above.

3. Monitor outdoor air and return air mixing plenum pressure.

G. Return Fan Control:
   1. The return fans will start once the supply fans status has been proven on. Once the return fans have started, the return fan VFD speed, will ramp up slowly and then modulate to maintain the static pressure, ahead of relief air damper, at set-point of 0.1" WC (adj. and shall be determined by the controls contractor in conjunction with the testing and balancing contractor). If the return fan is commanded on and the status is not received within 60 seconds (adj.) an alarm will be generated.
   2. The return/relief fan shall be soft-started through the variable speed drive. Normal position shall be zero RPM. Fan acceleration and deceleration rates shall be adjustable at the variable speed drive.
   3. Where the unit has multiple fans and the variable speed drives and fans shall modulate together to maintain static pressure setpoint.
   4. The return fan(s) shall run as described unless shut down on safeties.
   5. Airflow measuring stations provided by others located in each return fan inlet shall provide airflow (CFM) monitoring and tracking of actual fan volume.
   6. Minimum alarms shall be provided as follows:
      a. Provide alarm per fan if loss of signal, VSD alarm, or individual fan airflow drops below 1000 cfm (Adj).
      b. Return Fan Failure: Commanded on, but the status is off.
      c. Return Fan in Hand: Commanded off, but the status is on.
      d. Return Fan Belt Failure (if belt driven): Commanded on, status is on, but airflow is zero.
      e. Return Fan VSD fault.

H. Building Static Pressure / Relief Damper Control.
   1. Building differential static pressure sensors/transmitters shall provide a signal to monitor and control the air handling unit static pressure.
   2. The static pressure control shall provide a signal to proportionally position the relief air damper to maintain the static pressure at an adjustable setpoint.
      a. AHU-1: The unit shall maintain a positive pressure between the Stagehouse and the exterior. The sensors shall be located at accessible location at the upper catwalk and at the exterior wall and with the final location requiring confirmation with the design team. Initial setpoint is 0.01 inches w.g. positive.
   3. The static pressure control per air handling unit shall be individually tuned and delayed so that short term fluctuations in pressure due to entrances and wind shall not adversely impact performance.
      a. Alarms
1) A high space static pressure alarm shall be reported to the BAS if the pressure rises above an Operator adjustable setpoint. Initial setpoint 0.05 inches w.g. positive.
2) A low space static pressure alarm shall be reported to the BAS if the pressure drops below an Operator adjustable setpoint. Initial setpoint 0.05 inches w.g. negative.

I. Filter differential pressure monitor
   1. The controller shall measure the differential pressure across each filter bank.
   2. Warnings shall be provided as follows:
      a. Pre-filter change required: Filter differential pressure exceeds an adjustable user definable limit. Initial setpoint: 0.5 in. w.g.
      b. Final-filter change required: Filter differential pressure exceeds an adjustable user definable limit. Initial setpoint: 1.0 in. w.g.

J. Additional Warnings
   1. Provide the following additional warnings:
      a. High supply air temp (Greater than 10 degrees above setpoint)
      b. Low supply air temp (Greater than 10 degrees below setpoint)
      c. Return Fan Failure: Commanded on, but the status is off.
      d. Return Fan in Hand: Commanded off, but the status is on.
      e. Return Fan Belt Failure: Commanded on, status is on, but airflow is zero.
      f. Return Fan VSD fault
      g. High chilled water supply temperature (greater than 48° F).
      h. Outdoor air damper end-switch (alarm if damper is not closed when commanded closed)

K. Coordination of Air-Handling Unit Sequences: Ensure that all controls have common inputs and do not overlap in function.

L. Variable Frequency Drive Metering: The BAS shall monitor and record the peak (high and low) power demand readings from the variable frequency drives. These readings shall be recorded on a daily, month-to-date, and year-to-date basis and stored.

M. Theatrical Fog and Haze Effects: AHU-1 with AHU-5 Integration
   1. General: The air handling system shall be used to exhaust theatrical fog and haze effects. During this event, the air handling unit shall be operated as a 100% outdoor air volume unit with the relief air damper at 100% open.
   2. Fog Exhaust Control (BUL-14)
      a. A toggle switch controlled by the building automation system at the operator workstation shall allow for the system to be operated by a local Spring Wound Timer control panel with buttons as listed on M3.2B. The timer switch shall be located at the stage manager’s operation station position in the control room.
      b. Provide theatrical fog exhaust indicator lights adjacent to Spring Wound Timer control panel in control room. Lights shall be on as associated with each button of control. Red = Theatrical Fog Exhaust Off at BAS; Yellow/Amber = Theatrical Fog Exhaust Ready; and Green = Theatrical Fog Exhaust On.
      c. The spring wound time shall allow the occupant to operate the fan for an adjustable period of time of 1530 minutes. At the expiration of this time, the exhaust fan shall turn off.
      d. Provide a plastic laminate label with following text: that is indicated on M3.2B.
         Theatrical Fog Exhaust Status
         Green: Safe/Off
         Yellow: Ready
         Red: Exhaust On
         Note: Plastic laminate label shall match architectural signage requirements and shall be reviewed and confirmed by architecture.
      e. In addition, provide theatrical fog exhaust indicator lights on south wall of scene shop for remote monitoring of system. Lights shall be Red – Theatrical Fog Exhaust Off at BAS; Yellow/Amber – Theatrical Fog Exhaust Ready; and Green - Theatrical Fog Exhaust On.
      f. Control panel Spring wound timer, indicator lights, label, associated power and interlock wiring shall be provided by Division 23
3. Fog Exhaust Control
   a. Whenever the fog exhaust system is engaged by button timer operation, the indicator light shall be on for that mode, go from Red to Yellow/Amber and the following shall occur:
      1) AHU-5 Return fan shall be shutdown.
         (a) Theatrical fog exhaust system requires that the AHU-5 return air fan acceleration and deceleration rates shall be as fast as practically possible. These fan acceleration and deceleration rates are required to be tested and optimized by the controls contractor and shall be separately programmed with the associated theatrical fog exhaust sequence.
      2) AHU-1 Economizer outdoor air damper shall fully open.
         (a) Theatrical fog exhaust system requires that outdoor air economizer damper shall be a fast-operating type, with full stroke (closed to open) occurring in less than 5 seconds.
   b. Stagehouse relief damper control (BUL-14)
      1) Performance mode – Fog (dry ice)
         (a) Relief damper in Haze relief ductwork shall be closed.
         (b) Normal return motorized damper shall be open.
         (c) Result: Exhaust location will be low in north side of stagehouse
      2) Performance mode – Haze (haze/fog machine)
         (a) Relief damper in Haze relief ductwork shall be open.
         (b) Normal return motorized damper shall be closed.
         (c) Result: Exhaust location will be high in rear of stagehouse
   c. AHU-5 (make-up air) control
      1) The AHU-5 economizer air VAV boxes shall open and all remaining AHU-5 VAV boxes shall close.
      2) AHU-5 Economizer outdoor air damper shall fully open.
         (a) Theatrical fog exhaust system requires that outdoor air economizer damper shall be a fast-operating type, with full stroke (closed to open) occurring in less than 5 seconds.
      3) AHU-5 exhaust air damper shall fully open.
         (a) Theatrical fog exhaust system requires that relief air economizer damper shall be a fast-operating type, with full stroke (closed to open) occurring in less than 5 seconds.
      4) AHU-5 Economizer return air damper shall fully close.
         (a) Theatrical fog exhaust system requires that return economizer damper shall be a fast-operating type, with full stroke (closed to open) occurring in less than 5 seconds.
         (b) Return air damper shall be shutoff rated for return fan and supply fan full flow operating pressure with no leakage.
      5) AHU-5 Minimum outdoor air damper shall close.
   d. AHU-1 and AHU-5 Fan Control
      1) Once dampers have been positioned, AHU-5 Return Fan shall be off and AHU-1 supply and return air fan shall operate at full flow conditions (adj).
(a) Theatrical fog exhaust system requires that the AHU-1 and AHU-5 return air fan and supply air fan acceleration and deceleration rates shall be as fast as practically possible. These fan acceleration and deceleration rates are required to be tested and optimized by the controls contractor and shall be separately programmed with the associated theatrical fog exhaust sequence.

e. Fog Exhaust Air Temperature Control
1) An air temperature sensor located in the AHU-1 economizer air duct shall modulate AHU-5 chilled water coil and hot water coils to maintain an adjustable temperature setpoint. The temperature sensor shall be an averaging capillary type sensor. Initial setpoint is 65 Deg F.
   (a) AHU-5 Hot Water Heating Coil
      (i) The pre-heating coil control valve shall be proportionally positioned to maintain the temperature setpoint.
      (ii) The pre-heating coil control valve shall be a two-way modulating valve, normally open.
      (iii) Monitor hot water return temperature from coil. Alarm if hot water return temperature drops below 35 deg F (adj).
   (b) AHU-5 Cooling Coil
      (i) The cooling coil control valve shall modulate to maintain the temperature setpoint.
      (ii) The cooling coil control valve (normally open) shall be a two-way throttling valve.
      (iii) Monitor chilled water return temperature from coil.
2) In addition to AHU-5 discharge air temperature control, AHU-1 heating coil, AHU-1 chilled water coil, and AHU-1 hot water re-heat coil shall continue to operate to maintain discharge air and space temperature control setpoint. The air temperature sensor located in the AHU-1 economizer air duct shall modulate AHU-5 chilled water coil and hot water coils to maintain an adjustable temperature setpoint. The temperature sensor shall be an averaging capillary type sensor. Initial setpoint is 65 Deg F.

4. At the end of Fog Exhaust mode, systems shall be staged to return to normal operation. When returning to normal operation, damper operation and fan acceleration and deceleration rates shall have individual adjustment rates to create stable operation back to normal operation. Additional Warnings
5. Provide indicator on AHU-1 and AHU-5 graphics when Fog Exhaust operation is in operation.

3.7 AIR HANDLING UNITS AHU-2 THROUGH AHU-5 CONTROL SEQUENCE

A. General
1. Systems are variable volume, multi-zone, variable temperature system which provides heating, cooling, and dehumidification.
2. The units consist of supply fan(s), outside air/return air/relief air dampers, chilled water cooling coil(s), hot water heating coil(s), economizer dampers, outdoor air dampers, air filters, and return/relief fan(s).
3. The air handling system shall be controlled automatically through local direct digital control panels using PI and PID control methods. Sensing elements, damper and valve operators shall be electronic types. Safety and limit controls shall utilize local electric control loops.
4. Supply and return fans shall be interlocked via DDC to start and stop simultaneously under normal conditions.
5. In addition, signals from freezestat(s), fan differential, smoke detection, or pressure shutdown switches shall shut-down all fans including associated supply and return fans.
6. Each air handling unit shall have individual setpoints, schedules, alarms, safeties, etc. unless specifically noted elsewhere.
7. Refer to AHU-1 sequence of operation for AHU-5 operation during stage Fog / Haze operation.
8. Smoke Detectors: Refer to Division 28 for smoke detector and system shut down requirements.
9. Air Handling Unit Smoke Shutdown.
   a. Signal(s) from the fire alarm system shall be extended to connection points in the supply
      and/or return fan variable speed drive(s) to stop the unit fans if smoke is sensed within the
      air handling unit and/or a smoke zone/compartment served by the AHU. Upon fire alarm
      signal termination, AHU operation shall return to the normal operating conditions.
   b. Smoke alarms shall be programmable to allow (with approval of the Responding Authority)
      them to be defeated during use of heavy stage fog effects.
   c. AHU smoke detectors and fire alarm signal wiring to the fan variable speed drives will be
      provided by the Fire Alarm Contractor as work of Division 28.
   d. Refer to supply and return/relief fan articles for AHU related smoke/fire damper control.
   e. Means shall be available to terminate the AHU operation (stop fan operation) from a
      manual reset at the BAS and/or Fire Alarm Panel.
10. Supply Fan Discharge Static Pressure High Limit.
    a. A high limit pressure control shall stop the supply fan if the static pressure at the fan
       discharge exceeds the setpoint. The pressure sensing element shall be located between
       the fan and the first automatic control or fire/smoke damper. The high limit pressure switch
       shall be manually reset at the Operator Workstation.
    b. A supervisory alarm on the BAS shall indicate that the fan has tripped on high limit.
11. Return Fan Static Pressure High Limit.
    a. A high limit pressure control shall stop the return fan if the static pressure at the fan inlet
       exceeds the setpoint. The high limit pressure switch shall be manually reset at the Operator
       Workstation.
    b. A supervisory alarm on the BAS shall indicate that the fan has tripped on high limit.
12. Temperature Low Limit
    a. An averaging serpentined low limit temperature sensor located downstream of the heating
       coil shall provide a supervisory alarm on the BAS if signal an alarm onto the BAS if the
       temperature falls below 38° F. Unit shall shut down on low temperature limit if the
       temperature downstream of the unit coil(s) is below 35° F for any 1 foot section of sensor.
    b. Temperature low limit shall be manually reset through the Operator Workstation.
13. Provide a local alarm defeating switch for each air handling system.

B. Run Conditions
1. The air handling unit shall be operated continuously according to the building operating
   schedule and during schedulable events such as evening and weekend performances.
2. During unoccupied periods, the system shall maintain critical space temperature setpoints and
   all other space temperature at an adjustable minimum unoccupied heating temperature setpoint
   of 66 degrees and 78 degrees unoccupied cooling setpoint.
   a. Provide operator adjustable setback setpoint and warm-up and cool-down operations for
      the system.
   b. Setback mode shall include operating a single fan at an adjustable minimum speed.
   c. Provide settings for opening up air terminal units / VAV boxes to adjustable minimum
      positions during setback operations.
   d. Provide option (selectable by the operator) for outside-air damper(s) to be fully closed
      during unoccupied and warm-up and cool-down operations.
3. AHU Optimal Start: The unit shall start prior to scheduled occupancy based on the time
   necessary for the zone(s) to reach the(ir) occupied setpoint(s). The start time shall
   automatically adjust based on changes in outside air and zone temperatures.

C. Off Condition.
1. When the supply fan is off, the air-handling system components shall remain in the following
   positions:
   a. Return fans are off.
   b. Cooling coil chilled water control valve is closed.
      1) In the event of power failure, the valve shall fail open.
c. Heating coil control valve shall modulate to maintain temperature sensed downstream of the coil at 38°F (adjustable).
   1) In the event of power failure, the valve shall fail open.
d. Outside air dampers shall be closed.
e. Return air damper shall be open.
f. Relief air dampers shall be closed

D. Supply Fan Control
1. The supply fan(s) shall be operated continuously during building zone occupied hours and shall be off otherwise, except as to maintain minimum unoccupied temperature settings.
2. The supply fan shall be soft started through the variable speed drive. Normal position shall be zero rpm. Fan acceleration and deceleration rates shall be adjustable at the variable speed drive to provide stable operation and to prevent tripping of the high limit pressure control.
3. Where the unit has multiple fans and the variable speed drives and fans shall modulate together to maintain static pressure setpoint.
4. The supply fan(s) shall run as described unless shut down on safeties.
5. To prevent short cycling, the supply fan shall have an operator adjustable minimum run time. Initial minimum run time setting is 30 minutes.
6. Airflow measuring stations provided by others located in each supply fan inlet shall provide airflow (CFM) monitoring and tracking of actual fan volume.
7. Minimum alarms shall be provided as follows:
   a. Provide alarm per fan if loss of signal, VSD alarm, or individual fan airflow drops below 1000 cfm (Adj).
   b. Supply Fan Failure: Commanded on, but the status is off.
   c. Supply Fan in Hand: Commanded off, but the status is on.
   d. Supply Fan Belt Failure (if belt driven): Commanded on, status is on, but airflow is zero.
   e. Supply Fan VSD fault.

E. Supply Air Duct Pressure Control
1. Duct static pressure sensor / transmitter(s) shall provide signal to maintain the supply air duct static pressure at the setpoint by signaling the variable speed drives through the local control panel to vary the supply fan’s rotational speed.
2. The setpoint shall be the minimum static pressure necessary to operate the most hydraulically remote air terminal. Actual setpoint shall be field determined with the most hydraulically remote air terminal identified on the as-built drawings. Initial setpoint is 1 w.c. positive pressure.
3. The supply air static pressure setpoint shall be reset downward from the initial setpoint in increments to create stable operating conditions and eliminate hunting. The BAS contractor shall determine minimum static pressure setpoint during minimal fan operations and under a call for heating or cooling from any zone.
   a. Note: Supply air static pressure pressure reset shall occur only after supply air temperature reset has been satisfied (lowest priority reset sequence).
4. Minimum warnings shall be provided as follows:
   a. High supply air static pressure as described above
   b. Low supply air static pressure: If the supply air static pressure is 20% less than setpoint.

F. Supply Air Temperature Control
1. A supply air temperature sensor (DAT) located in the supply air plenum (downstream of the supply fan) shall modulate the chilled water cooling coil control valve to maintain an adjustable supply air temperature setpoint. The supply air temperature sensor shall be an averaging capillary type sensor. Initial setpoint is 54 Deg F.
2. Dehumidification reset control: The supply air temperature set-point shall be reset downward in .5 deg F increments to 50 Deg F to maintain maximum return air humidity set-point of 56% (adj). Reset shall temperature shall utilize PID controls. Discharge air temperature shall return to initial setpoint at start of new occupied period.
3. Supply air temperature reset control: The supply air temperature set-point shall be reset upwards in 1 deg F increments (adj) over 30 minutes (adj) up to a discharge air temperature of 60 Deg F (adj) based on air terminal unit/reheat coil needs and to maintain the space humidity set-point using the highest supply air temperature possible. Reset shall temperature shall utilize PID controls.
   a. Reset control shall only be allowed if all temperature and humidity setpoints are maintained.
   b. Supply air temperature reset up shall be engaged whenever all air terminal unit/reheat coil valves are at least 60% open (adj)
   c. Supply air temperature shall return back to initial temperature setpoint once any air terminal unit/reheat coil valve is 20% open or less (adj).
   d. Discharge air temperature shall return to initial setpoint at start of new occupied period.

G. Chilled-Water Cooling Coil Control
1. The cooling coil control valve shall be proportionally positioned to maintain the AHU DAT / supply air temperature set-point.
2. The cooling coil control valve (normally open) shall be a pressure independent two-way throttling valve.
3. Monitor chilled water return temperature from coil.

H. Hot Water Heating Coil
1. The heating coil control valve shall be proportionally positioned to maintain the discharge air setpoint.
2. The pre-heating coil control valve shall be a two-way modulating valve, normally open.
3. Monitor hot water return temperature from coil. Alarm if hot water return temperature drops below 60 deg F (adj).

I. Outdoor Air / Economizer Control
1. Minimum Outside Air Damper Control
   a. Minimum outdoor air quantities are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Unoccupied Mode</th>
<th>Demand Control Minimum Mode</th>
<th>Minimum Occupied Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHU-2</td>
<td>0 cfm (adj)</td>
<td>3,000 cfm</td>
<td>Refer to AHU Schedule (adj)</td>
</tr>
<tr>
<td>AHU-3</td>
<td>0 cfm (adj)</td>
<td>2,500 cfm</td>
<td>Refer to AHU Schedule (adj)</td>
</tr>
<tr>
<td>AHU-4</td>
<td>0 cfm (adj)</td>
<td>1,000 cfm</td>
<td>Refer to AHU Schedule (adj)</td>
</tr>
<tr>
<td>AHU-5</td>
<td>0 cfm (adj)</td>
<td>1,000 cfm</td>
<td>2,000 cfm</td>
</tr>
</tbody>
</table>

   b. Whenever the supply fan is started, the outside air damper shall be proportionally opened and controlled to maintain the adjustable minimum outside air quantity.
   c. Minimum ventilation control
      1) During occupied mode, the system shall provide the demand control minimum outside air CFM volume according to ASHRAE 62.1.
      2) Minimum outdoor air CFM quantity shall be the determined by the maximum of one of the following:
         (a) Minimum Demand Control Mode outdoor air volume
         (b) The minimum amount of outdoor air required to meet static pressure setpoint but minimum outdoor air shall not raise above Minimum Occupied Mode outdoor air cfm.
         (c) For AHU-3 and AHU-5, the minimum outdoor needed to maintain pressurization whenever the dust collector or paint booth is in operation.
      3) Demand Control Minimum Ventilation Control
         (a) The Demand Ventilation Controls shall first increase zone minimum airflow to satisfy ventilation requirements, and then increase the outdoor air rate at the air handler as described in the following sequence.
(b) At any zone with CO2 sensors: Upon a rise in zone CO2 concentration above setpoint (1200 ppm initial setpoint), the minimum occupied airflow setpoint at the zone VAV terminal shall first slowly raise from the current airflow rate up to full flow until CO2 setpoint is maintained.
   (i) In the case of AHU-5, use return air CO2 reading for demand control reading.

(c) At the Air Handler: Upon continued call for ventilation (based on continued rise in critical zone CO2 concentration with VAV terminal at ventilation override maximum setpoint, then increase the minimum outdoor air rate (or damper position) from Demand Control minimum to Minimum occupied mode cfm.

(d) Provide warning alarm whenever any space CO2 concentrations exceed 1,300 ppm for longer than 20 minutes (adj).

4) Dust Collector and Paint Booth Minimum Outdoor Air Override
   (a) AHU-5: Monitor the status of the dust collector system. Whenever the dust collector is in operation, the minimum outdoor air shall be at a minimum of 3,500 cfm (adj).
   (b) AHU-3: Monitor the status of the paint booth system. Whenever the paint booth is in operation, the minimum outdoor air shall be at a minimum of 5,100 cfm (adj).

5) This function shall be operational only during minimum outside air modes.

2. Economizer Outdoor Air Control
   a. BAS shall modulate the outdoor air damper and mixed air damper to provide “free cooling” when conditions merit.
   b. While conditions merit, dampers shall be modulated in a DA PID loop to maintain mixed air temperature at a setpoint as specified for the individual unit. Economizer logic shall remain enabled during setback cooling where applicable.
   c. Dry Bulb Switch: Economizer mode shall be active while: 1) The unit is energized 2) AND, when outside air temperature falls below the switching setpoint of 63°F (adj.) (with 2°F (adj.) cycle differential - Enable at 63°F, Disable at 65°F). 3) AND, either of the following are true:
      1) Outside air temperature is less than 55°F (adj.)
      2) OR, Return (exhaust) air humidity is not greater than 55% (with 2% (adj.) cycle differential)
   d. Economizer mode shall be inactive when outside air temperature rises above switching setpoint, dampers shall return to their scheduled minimum positions as specified above.

3. Monitor outdoor air and return air mixing plenum pressure.

J. Return Fan Control:
   1. The return fans will start once the supply fans status has been proven on. Once the return fans have started, the return fan VFD speed, will ramp up slowly and then modulate to maintain the static pressure, ahead of relief air damper, at set-point of 0.1" WC (adj. and shall be determined by the controls contractor in conjunction with the testing and balancing contractor). If the return fan is commanded on and the status is not received within 60 seconds (adj.) an alarm will be generated.
   2. The return/relief fan shall be soft-started through the variable speed drive. Normal position shall be zero RPM. Fan acceleration and deceleration rates shall be adjustable at the variable speed drive.
   3. Where the unit has multiple fans and the variable speed drives and fans shall modulate together to maintain static pressure setpoint.
   4. The return fan(s) shall run as described unless shut down on safeties.
   5. Airflow measuring stations provided by others located in each return fan inlet shall provide airflow (CFM) monitoring and tracking of actual fan volume.
   6. Minimum alarms shall be provided as follows:
      a. Provide alarm per fan if loss of signal, VSD alarm, or individual fan airflow drops below 1000 cfm (Adj).
      b. Return Fan Failure: Commanded on, but the status is off.
      c. Return Fan in Hand: Commanded off, but the status is on.
      d. Return Fan Belt Failure (if belt driven): Commanded on, status is on, but airflow is zero.
K. Building Static Pressure / Relief Damper Control.
   1. Building differential static pressure sensors/transmitters shall provide a signal to monitor and control each air handling unit static pressure.
   2. The static pressure control shall provide a signal to proportionally position the relief air damper to maintain the static pressure at an adjustable setpoint.
      a. AHU-2: The unit shall maintain a positive pressure between the Audience Chamber and the Lobby to the east. The sensors shall be located at accessible locations on the separating wall that is visually inconspicuous and with the final location requiring confirmation with the design team. Initial setpoint is 0.01 inches w.g. positive.
      b. AHU-3: The unit shall maintain a positive pressure between the Sector C corridor and the building exterior to the West. The exterior building pressure input shall utilize a global signal, and the interior sensor shall be located at an accessible location in the corridor that is visually inconspicuous and with the final location requiring confirmation with the design team. Initial setpoint is 0.02 inches w.g. positive.
      c. AHU-4: The unit shall maintain a positive pressure between the Lobby and the building exterior. The exterior building pressure input shall utilize a global signal, and the interior sensor shall be located at an accessible location in the Lobby that is visually inconspicuous and with the final location requiring confirmation with the design team. Initial setpoint is 0.02 inches w.g. positive.
      d. AHU-5: The unit shall maintain a positive pressure between the Scene Shop and the building exterior. The exterior building pressure input shall utilize a global signal, and the interior sensor shall be located at an accessible location that is visually inconspicuous and with the final location requiring confirmation with the design team. Initial setpoint is 0.01 inches w.g. positive.

   3. Each static pressure control per air handling unit shall be individually tuned and delayed so that short term fluctuations in pressure due to entrances and wind shall not adversely impact performance.
      a. Alarms
         1) A high space static pressure alarm shall be reported to the BAS if the pressure rises above an Operator adjustable setpoint. Initial setpoint 0.05 inches w.g. positive.
         2) A low space static pressure alarm shall be reported to the BAS if the pressure drops below an Operator adjustable setpoint. Initial setpoint 0.05 inches w.g. negative.

L. Filter differential pressure monitor
   1. The controller shall measure the differential pressure across each filter bank.
   2. Warnings shall be provided as follows:
      a. Pre-filter change required: Filter differential pressure exceeds an adjustable user definable limit. Initial setpoint: 0.5 in. w.g.
      b. Final-filter change required: Filter differential pressure exceeds an adjustable user definable limit. Initial setpoint: 1.0 in. w.g.

M. Additional Warnings
   1. Provide the following additional warnings:
      a. High supply air temp (Greater than 10 degrees above setpoint)
      b. Low supply air temp (Greater than 10 degrees below setpoint)
      c. Relief Fan Failure: Commanded on, but the status is off.
      d. Relief Fan in Hand: Commanded off, but the status is on.
      e. Relief Fan Belt Failure: Commanded on, status is on, but airflow is zero.
      f. Relief Fan VSD fault
      g. High chilled water supply temperature (greater than 48° F).
      h. Outdoor air damper end-switch (alarm if damper is not closed when commanded closed)

N. Coordination of Air-Handling Unit Sequences: Ensure that all controls have common inputs and do not overlap in function.
O. “Rogue Zone” lockout: Operator shall be able to identify up to 10 “rogue zones” on each air handling unit which do not tend to follow the same heating/cooling pattern as the rest of the system. These zones shall be ignored by any polling of the sequences described above.

P. Variable Frequency Drive Metering: The BAS shall monitor and record the peak (high and low) power demand readings from the variable frequency drives. These readings shall be recorded on a daily, month-to-date, and year-to-date basis and stored.

Q. Black Box Fog/Control:
   1. General: AHU-2 and VAV 2.08 shall be used to purge theatrical fog and haze effects.
   2. Fog Control (BUL-14)
      a. Provide a toggle switch controlled by the building automation system and a local control panel spring Wound Timer at the operator workstation in Control Room 2223. Toggle switch shall allow for the Fog system to be operated by the local button Spring Wound Timer.
      b. Provide exhaust indicator lights adjacent to Spring Wound Timer control panel in control room. Lights shall be on as associated with each button of control. Green—Theatrical Fog Off at BAS; and Red—Theatrical Fog On.
      c. The spring wound time shall allow the occupant to operate the VAV box airflow for an adjustable period of time of 1530 minutes. At the expiration of this time, the VAV box shall return to normal operation.
      d. Provide a plastic laminate label with following text:
         1) Theatrical Fog Status
         2) Green: Safe Normal/Off
         3) Red: Air Exhaust On
         4) Note: Plastic laminate label shall match architectural signage requirements and shall be reviewed and confirmed by architecture.
      e. Toggle switch, spring wound timer, indicator lights, label, associated power and interlock wiring shall be provided by Division 23.
   3. Fog System Control: Whenever the fog exhaust system is engaged by timer operation, the indicator light shall be on from Green to Red and the following shall occur:
      a. VAV 2.08 shall be fully open and AHU-2 supply fan static pressure setpoint shall raise to operating setpoint to allow full box airflow setting.
      b. AHU-2 Minimum Outside Air Damper Control: Whenever mode is in operation and not in Economizer mode, the outdoor air flow setpoint shall be at Minimum Occupied outdoor air setpoint and not Demand Control setpoint. Outdoor Air Damper Control shall return to normal operation at end of Fog sequence.
      c. AHU-2 Fan Control: Theatrical fog system requires that the AHU-2 fan acceleration and deceleration rates shall be as fast as practically possible. These fan acceleration and deceleration rates are required to be tested and optimized by the controls contractor and shall be separately programmed with the associated theatrical fog sequence.
      d. Fog Exhaust Air Temperature Control: VAV 2.08 shall be controlled to maintain space temperature setpoint.
      e. At the end of the Fog mode, systems shall be staged to return to normal operation prior to activation of sequence. When returning to normal operation, fan acceleration and deceleration rates shall have individual adjustment rates to create stable operation back to normal operation.
   4. Provide indicator on AHU-2 and VAV 2.08 graphics when Fog operation is in operation

3.8 AIR HANDLING UNITS: EXISTING VALADE AHU-2

A. General
   1. Existing air handling unit shall be modified to be variable volume, single-zone, variable temperature system which provides heating, cooling, and dehumidification.
   2. The units consist of an existing supply fan, new outside air/return air/relief air dampers, chilled-water cooling coil, steam heating coil, air filters, and existing return.
3. The air handling system shall be controlled automatically through local direct digital control panels using PI and PID control methods. Sensing elements, damper and valve operators shall be electronic types. Safety and limit controls shall utilize local electric control loops.

4. Supply and return fans shall be interlocked via DDC to start and stop simultaneously under normal conditions.

5. In addition, signals from new upstream temperature sensor and smoke detection shall shut-down supply and return fans.

6. Air handling unit shall have individual setpoints, schedules, alarms, safeties, etc. unless specifically noted elsewhere.

Safety and Unit Protection

1. Smoke Detectors: Refer to Division 28 for smoke detector and system shut down requirements.

2. Air Handling Unit Smoke Shutdown.
   a. Existing AHU smoke detectors and fire alarm signal wiring shall be re-wired to the new fan variable speed drives will be provided by the Fire Alarm Contractor as work of Division 28.
   b. Refer to supply and return/relief fan articles for AHU related smoke/fire damper control.
   c. Means shall be available to terminate the AHU operation (stop fan operation) from a manual reset at the BAS and/or Fire Alarm Panel.

3. Temperature Low Limit
   a. The mixed air temperature sensor located upstream of coils shall provide a supervisory alarm on the BAS if signal an alarm onto the BAS if the temperature falls below 38° F. Unit shall shut down on low temperature limit if the temperature downstream of the unit coil(s) is below 35° F.
   b. Temperature low limit shall be manually reset through the Operator Workstation.

B. Run Conditions

1. The air handling unit shall be operated continuously according to the building operating schedule and during schedulable events such as evening and weekend performances.

2. During unoccupied periods, the system shall maintain critical space temperature setpoints and all other space temperature at an adjustable minimum unoccupied heating temperature setpoint of 66 degrees and 78 degrees unoccupied cooling setpoint.
   a. Provide operator adjustable setback setpoints and warm-up and cool-down operations for the system.
   b. Provide option (selectable by the operator) for outside-air damper(s) to be fully closed during unoccupied and warm-up and cool-down operations.

3. AHU Optimal Start: The unit shall start prior to scheduled occupancy based on the time necessary for the zone(s) to reach the(ri) occupied setpoint(s). The start time shall automatically adjust based on changes in outside air and zone temperatures.

C. Off Condition.

1. When the supply fan is off, the air-handling system components shall remain in the following positions:
   a. Return fans are off.
   b. Cooling coil chilled water control valve is closed.
      1) In the event of power failure, the valve shall fail open.
   c. Existing steam heating coil control valve shall modulate to maintain temperature sensed downstream of the coil at 38º F (adjustable).
      1) In the event of power failure, the valve shall fail open.
   d. Outside air dampers shall be closed.
   e. Return air damper shall be open.
   f. Relief air dampers shall be closed

2. Provide operator adjustable sequence to allow return fan to operate during unoccupied periods at adjustable operating speeds and then return to normal operation on a call for temperature control or occupancy.

D. Supply Air Volume and Temperature Control
1. Space temperature sensors shall provide a signal to proportionally adjust the unit flow rate, the chilled water cooling coil and the steam heating coil in sequence to provide cooling or heating to maintain the space temperature setpoint.

2. Space temperature setpoints:
   a. Initial space temperature set points
      1) Occupied Temperature (cooling): 74 degrees F
      2) Occupied Temperature (heating): 70 degrees F
      3) Unoccupied Temperature (cooling): 78 degrees F
      4) Unoccupied Temperature (heating): 66 degrees F

3. The supply fan shall be soft started through the variable speed drive. Normal position shall be zero rpm. Fan acceleration and deceleration rates shall be adjustable at the variable speed drive to provide stable operation and to prevent tripping of the high limit pressure control.

4. On a call for heating, the fan shall modulate to minimum fan speed and the steam control valve shall be proportionally positioned from fully closed to fully open to maintain the space temperature setpoint. After heating coil is full open and temperature not satisfied, sequence fan cfm from minimum position to design airflow to satisfy space temperature setpoint. Initial minimum supply fan speed is 50% (adj).

5. On a call for cooling and when cooling is available based on monitoring of chilled water temperature sensor, the fan shall modulate to minimum fan speed and the chilled water control valve shall be proportionally positioned from fully closed to fully open to maintain the space temperature setpoint. After cooling coil is full open and temperature not satisfied, sequence fan cfm from minimum position to design airflow to satisfy space temperature setpoint. Initial minimum supply fan speed is 50% (adj).

6. Dehumidification reset control: When chilled water is available and the return air return air humidity exceeds a set-point of 58% (adj), the chilled water coil shall be modulate to maintain a discharge air temperature of 53 deg F (adj). Dehumidification reset control shall be disengaged whenever return air humidity is lower than 50% (adj).

E. Chilled Water Cooling Coil Control
   1. The building automation system shall monitor existing Valade chilled water system temperature to determine if chilled water is available.
   2. When chilled water is available, the cooling coil control valve shall be proportionally positioned to maintain the space temperature set-point.
   3. The cooling coil control valve (normally open) shall be a two-way throttling valve.
   4. On a call for cooling and if chilled water temperature is not available, a supervisory alarm shall be sent to the building automation system.

F. Steam Heating Coil
   1. The existing heating coil control valve shall be proportionally positioned to maintain the space temperature setpoint.

G. Outdoor Air / Economizer Control
   1. Minimum Outside Air Damper Control
      a. Minimum outdoor air quantities are as follows:

      | Unoccupied Mode | Demand Control Minimum Mode | Minimum Occupied Mode |
      |-----------------|----------------------------|-----------------------|
      | 0 cfm (adj)     | 1,000 cfm                 | 2,000 cfm             |

      b. Whenever the supply fan is started, the outside air damper shall be proportionally opened and controlled to maintain the adjustable minimum outside air quantity.
      c. Minimum ventilation control
         1) During occupied mode, the system shall provide the demand control minimum outside air CFM volume according to ASHRAE 62.1.
         2) Demand Control Minimum Ventilation Control
(a) The Demand Ventilation Controls shall first increase supply fan speed to satisfy ventilation requirements, and then increase the outdoor air rate at the air handler as described in the following sequence.

(b) Upon a rise in zone CO2 concentration above setpoint (1200 ppm initial setpoint), the minimum supply fan speed shall first slowly raise from the current speed rate up to full flow until CO2 setpoint is maintained.

(c) Upon continued call for ventilation (based on continued rise in critical zone CO2 concentration with supply fan at maximum setpoint, then increase the minimum outdoor air rate (or damper position) from Demand Control minimum to Minimum occupied mode cfm.

(d) Provide warning alarm whenever any space CO2 sensor exceed 1,300 ppm for longer than 20 minutes (adj).

3) This function shall be operational only during minimum outside air modes.

2. Economizer Outdoor Air Control

   a. BAS shall modulate the outdoor air damper and mixed air damper to provide “free cooling” when conditions merit.

   b. While conditions merit, dampers shall be modulated in a DA PID loop to maintain mixed air temperature at a setpoint as specified for the individual unit. Economizer logic shall remain enabled during setback cooling where applicable.

   c. Dry Bulb Switch: Economizer mode shall be active while: 1) The unit is energized 2) AND, when outside air temperature falls below the switching setpoint of 63°F (adj.) (with 2°F (adj.) cycle differential - Enable at 63°F, Disable at 65°F). 3) AND, either of the following are true:

      1) Outside air temperature is less than 55°F (adj.)
      2) OR, Return (exhaust) air humidity is not greater than 55% (with 2% (adj.) cycle differential)

   d. Economizer mode shall be inactive when outside air temperature rises above switching setpoint, dampers shall return to their scheduled minimum positions as specified above.

H. Return Fan Control:

   1. The return fans will start once the supply fans status has been proven on. Once the return fans have started, the return fan VFD speed, will ramp up slowly and then modulate to maintain a fixed fan speed offset from the supply speed. Initial offset is 10% (adj) from supply fan speed.

   2. The return/relief fan shall be soft-started through the variable speed drive. Normal position shall be zero RPM. Fan acceleration and deceleration rates shall be adjustable at the variable speed drive.

   3. The return fan(s) shall run as described unless shut down on safeties.

I. Additional Warnings

   1. Provide the following additional warnings:

      a. High supply air temp (Greater than 10 degrees above setpoint)
      b. Low supply air temp (Greater than 10 degrees below setpoint)
      c. Return Fan Failure: Commanded on, but the status is off.
      d. Return Fan in Hand: Commanded off, but the status is on.
      e. Return Fan Belt Failure: Commanded on, status is on, but airflow is zero.
      f. Return Fan VSD fault
      g. High chilled water supply temperature (greater than 48° F).

J. Coordination of Air-Handling Unit Sequences: Ensure that all controls have common inputs and do not overlap in function.

K. Variable Frequency Drive Metering: The BAS shall monitor and record the peak (high and low) power demand readings from the variable frequency drives. These readings shall be recorded on a daily, month-to-date, and year-to-date basis and stored.
3.9 AIR COOLED CHILLER AND PUMPS OPERATING SEQUENCE

A. Scope: This control type applies to the chilled water system air-cooled chiller system, the variable-chilled water pumps, motorized chilled water shut-off valves at the chiller, motorized modulating chilled water valves at air handling unit, chiller on-board controllers, interface with the building DDC systems, variable speed drives for the variable-speed pumps, controls/sensors for monitoring and control to form a complete and operating system.

B. The building DDC system (this temperature control contractor) shall sequence the running of chiller and pumps through interface with the chiller controllers and the variable-primary pump variable speed drives. The building air handling units shall be provided with a continuous supply of chilled water during cooling season, when outdoor air economizer operation is not possible due to conditions outdoors.

C. The temperature control contractor shall provide the following:
   1) Supply and return chilled water temperature and pressure reference sensors on the primary main supply and return headers to the chiller and building piping systems and coils.
   2) Modulating DDC control valves at each air handling unit cooling coil and heat exchanger (installed by the mechanical contractor).
   3) Full interface control and monitoring of the chiller through the on-board chiller controllers.
   4) Alternating variable-primary chilled water pump operation, to allow for equal run time of each pump, including the backup (redundant) pump.
   5) Chilled water flow proving switch at chiller return, to prove chiller flow.
   6) Motorized isolation valve for chiller, when not running, located on the return side of each chiller.
   7) Monitoring of all temperature and pressure sensors through DDC system.
   8) Monitoring of chiller on-board safety controls.
   9) Pressure differential reference sensors for control of the VSD speed control of the pumps.
   10) Field wiring/interface with the chiller systems.

D. Chiller Control Sequence
   1. Through the DDC system preset outdoor temperature schedule, upon sensing outdoor temperatures above a temperature (initial setpoint 42 F) and humidity levels (enthalpy conditions), command the chillers on to energize to generate chilled water for the building. The motorized valve for the chiller shall fully open first and prove through end switch that it is open. When valve is open, the variable-primary pump shall energize through the VSD and shall modulate the speed to maintain system flow requirements based on the differential pressure reference sensor. Upon proving water flow through the operating chiller, energize the chiller through the on-board controller and generate chilled water at temperature scheduled. Operate chillers through steps of capacity.

E. Chilled Water Pump Controls:
   1. Variable-Primary Pumps: The DDC system shall command each of the variable-primary chilled water pumps to start. One of the variable-primary pumps is always redundant, for emergency operation in the event of an operating pump failure. Mount the flow switch in the primary chilled water circuit. Upon command to energize a pump, the switch shall prove flow before allowing the chiller to energize. Provide current sensors at each pump. In the event of loss of flow/pump motor failure, command the backup pump to operate. Send failure alarm to the DDC system.
   2. To maintain the required minimum evaporator flow rate in the chiller the chilled water bypass valve located between the chilled water supply and return lines shall modulate open to maintain the following minimum flows as measured by the flow meter (verify actual minimum GPM flow requirement with chiller manufacturer).
   3. Circulating Pump(s): N+1, Variable Volume.
a. The chiller control system will start and stop the pumps. Lead pump shall operate continuously. System software command will adjust the variable speed drive to maintain system DP pressure set point as measured by a DP water pressure sensor located near the remote end of each loop.

b. Automatic back-up Pump Operation: Provide programmable automatic lead –lag pump controls with automatic operation of lag pump in the event of lead pump failure along with pump fail alarms. Manual return the system to normal primary pump operation after pump failure has been corrected. Clear failure alarms.

c. Alternate the operation of the pumps to provide equal run time for each. The DDC system shall automatically switch operation of the pumps based on a runtime schedule.

4. If chilled water loop temperature setpoint is met while both chillers are not in operation, ensure that one chiller control valve is open.

5. If there is ever a call for chilled water pump operation, one of the chiller chilled water control valves shall be open.

F. Start and Stop Chiller:

1. The DDC system shall command the chiller system to start based on a preset outdoor temperature schedule. The chiller shall not be allowed to energize until flow has been proven through the flow switch in the primary chilled water mains. Upon proof of flow, the chiller controller shall energize and modulate the operation of the compressors to maintain required discharge chilled water temperatures. The chiller shall be off when outdoor temperature conditions permit use of full economizer damper operation at the air handling/fan coil systems.

2. The outdoor temperature schedule shall not disengage chilled water pump operation if chilled water loop temperature setpoint is met and there is still a need for cooling.

3. Alarm Chiller Start Failure: The chiller controller shall signal a chiller failure to start alarm at the DDC system.

G. Chilled-Water Supply Temperature:

1. Provide temperature sensors in each of the common chilled water supply and return piping loops.

2. Chilled water temperature shall be maintained to provide between 42 Degrees F and 48 Degrees F based on AHU chilled water control valve positions / demand to provide the warmest supply water temperature required to maintain the space temperature and/or humidity conditions.

   a. Provide a BAS warning whenever chilled water temperature setpoint is 2 deg F (adj) outside of temperature setpoint.

   b. Provide a BAS alarm whenever chilled water temperature setpoint is 4 deg F (adj) outside of temperature setpoint.

H. Chilled Water System Staging:

1. The chiller plant control system will start and stop the chilled water pumps and chillers based upon chiller plant supply water temperature setpoint and outdoor air temperature.

2. The chiller plant control system shall initiate the start of the next chiller in the sequence whenever the chilled water load, as determined by the system supply water temperature, is not met for 20 (adj) minutes. System shall use PI and PID control methods to optimizing sequencing of chillers and associated systems on and off.

   a. When staging the next chiller on, the associated chiller chilled water control valve shall first open slowly enough so that chilled water flow rate and system pressure shall not drop below minimum chiller operating points.

   b. The chiller plant control system will unload operating chillers to an operator editable current limit prior to starting a lag chiller.

   c. Lag chillers shall start in a similar manner to the lead chiller start sequence.

3. The chiller plant control system shall initiate the shut down of the next chiller in the sequence whenever excess chilled water capacity exists, as determined by percent run load amps, for 20 minutes. System shall use PI and PID control methods to optimizing sequencing of chillers and associated systems on and off.
a. When staging the next chiller off, the associated chiller shall be disengaged first before slowly closing the chilled water control valve so that chilled water flow rate and system pressure shall not rise significantly to cause issues with system control.

   a. Chiller rotation shall be initiated based on an operator entered runtime interval or manually through a software switch at the Operator Workstation. The method of sequence shall be operator selectable.
   b. Chiller cycling caused by normal system load fluctuations shall cause the chillers to change rotation sequence or at the operator’s option, chillers may be forced into the new rotation sequence at the time of sequence change.
   c. Provide an operator option for manual selection of lead chiller. Indicate selectable option on operator station display.

I. Interface the chiller with the building automation system (BAS) so the following features are provided at the Central Building Control Station.
   a. Evaporator refrigerant pressure
   b. Evaporator refrigerant temperature
   c. Evaporator approach temperature
   d. Condenser refrigerant pressure
   e. Condenser refrigerant temperature
   f. Condenser approach temperature
   g. Compressor refrigerant discharge temperature
   h. Compressor refrigerant suction temperature

3.10 HEATING WATER SYSTEM CONTROL

A. Heating-Water Supply Temperature: Integral boiler controls modulate burners, stage lead-lag boilers, or stage burner level to maintain heating water loop temperature set point of 120 degrees F.

B. Through the DDC system preset outdoor temperature schedule, upon sensing outdoor temperatures below a temperature (initial setpoint 80 F), command the boiler systems on to energize to generate hot water for the building. The motorized valve for the lead boiler shall fully open first and prove through end switch that it is open. When valve is open, the variable-primary pump shall energize through the VSD and shall modulate the speed to maintain system flow requirements based on the differential pressure reference sensor. Upon proving water flow through the boiler, energize the boiler through the on-board controller and generate boiler water at temperature scheduled. Operate boiler system through steps of capacity.

C. Boiler System
   1. Boiler Status: Start/Stop:
      a. The system operator will manually enable and disable each of the boilers through the DDC system software interface to the boiler control panels.
   2. Emergency shut off:
      a. A wall switch located near the boiler room exit will be hard wired to the boiler control panel to shutdown the boilers and provide a DDC system alarm. Provide a manual reset at the boiler control panel.
   3. Operation: The boiler control panel shall control the following for each boiler system:
      a. Boiler sequencing
      b. Boiler output
      c. Pump start / stop
      d. Temperature reset
   4. Boiler-Water Supply Temperature Reset:
      a. DDC system software will reset heating-water supply temperature when outdoor-air temperature drops below the following conditions:
         1) 140 degrees F (adj) heating water when outdoor-air temperature is 10 degrees F (adj) outdoor-air temperature or colder.
2) System shall return to normal operating setpoint (120 degrees F) when outdoor-air temperature is above 10 deg F (adj).

5. Display: Include custom dynamic color graphics for each system including the following:
   1) Boiler(s) status: enabled/disabled
   2) Boiler Operation: On/Off
   3) Emergency Shutoff status: Enable/Disable
   4) Outdoor-air temperature.
   5) System on/setpoint.
   6) Heating-water return temperature.
   7) Heating-water supply temperature.
   8) Heating-water supply temperature set point.
   9) Heating-water supply temperature reset schedule and setpoints
   10) Pump operation
   11) Pump speed
   12) Alarms

D. Heating Hot Water Pump Operation
   1. Differential pressure sensors (two) with their sensing elements located in the heating hot water supply and return piping shall provide signals to maintain the differential pressure at setpoint by varying the rotational speed of the pump(s).
   2. The differential pressure stations locations are indicated in the floor plans and system schematics in the Drawings.
   3. The controller shall monitor the two differential pressure setpoints, and shall vary the speed of the pumps in order to maintain the differential pressure of the branch with the greatest proportional offset from setpoint. Both setpoints shall be adjustable.
   4. The differential pressure setpoint shall be the minimum system differential pressure necessary to operate the most hydraulically remote coil or terminal unit. Actual system differential pressure setpoints to be field determined.
   5. The system differential pressure setpoint shall be optimized according to valve position.
   6. Pump Lead/Lag operation
      a. The two heating hot water pumps shall operate in a lead/lag fashion.
      b. The controller shall measure system heating hot water differential pressure and modulate the hot water pump variable speed drives in sequence to maintain the system hot water differential pressure setpoint.
      c. Once started, the minimum variable speed drive speed is 25% adjustable
   7. Lead/Lag Pump Rotation
      a. The designated lead pump shall rotate to the second pump upon one of the following conditions:
         1) Manually through a software switch at the Operator Workstation
         2) If pump runtime (adjustable) is exceeded
      b. In the event of a failure of the lead pump or the VSD for the lead pump, the lag pump shall automatically assume the status of lead pump.
   8. System Bypass Valve Operation
      a. To allow for minimum flow in the system in the event that the load control valves are closed or modulated below the minimum stable flow on the pump, the Controller shall open the heating water system bypass valve under the following conditions:
         1) If only one pump is running to maintain system differential pressure at set point, and the VFD of that pump is at minimum pump setting, modulate system bypass valve to maintain differential pressure setpoint.
         2) Once the pump speed is 5 Hz above minimum setting (adjustable) for more than 5 minutes (adjustable), close the bypass valve.
   9. If there is ever a call for hot water pump operation, one of the boiler hot water control valves shall be open.

E. Operator Station Display: Indicate the following on operator workstation display terminal:
   1. DDC system graphic.
2. DDC system on-off indication.
3. Heating system status: (enabled/disabled)
4. Emergency Shutoff status: Enable/Disable
5. Time and time schedule.
6. Boiler status
7. Boiler fire rate
8. Boiler valve position
9. Boiler pump status
10. Hot-water pump(s) on-off status. (One for each pump)
11. Hot-water pump(s) on-off indication. (One for each pump)
12. Hot-water flow indication: gpm (One for each pump)
13. Hot-water supply temperature.
14. Hot-water supply temperature: Set point
15. Hot-water return temperature.
16. Heating-water supply temperature reset schedule and setpoints
17. Hot water differential pressure.
18. Calculated heating system use in MBH (based on flow rate, supply and return temperatures)
19. Hot water system Bypass Valve position
20. Outdoor air temperature
21. Alarms shall be provided as follows:
   a. High supply water temperature: Supply water temperature exceeds 160 °F (adjustable)
   b. Low supply water temperature: Supply water temperature is below 110 °F (adjustable)
   c. High Hot Water Differential Pressure: If the hot water differential pressure is 25% (adjustable) greater than setpoint.
   d. Low Hot Water Differential Pressure: If the hot water differential pressure is 25% (adjustable) lower than setpoint.
   e. Boiler alarm
   f. Pump Failure: Pump commanded on, status is off. (One alarm per pump)
   g. Pump running in Hand: Pump Commanded off, status is on (One alarm per pump)
   h. Pump run-time exceeded. (One per pump)

### 3.11 VRV CONDENSING UNIT & FAN COIL UNITS

A. Sequences shall be performed by combination of factory controllers and building automation system.

B. Operational information provided by factory BACnet controller accessed through BAS. Space temperatures to be displayed on operator interface.

C. Supply Temperature and Fan Control
   1. The unit shall run according to a user definable time schedule in the following modes:
      a. The unit shall maintain:
         1) A 75 deg F cooling zone setpoint
         2) A 68 deg F heating zone setpoint
   2. Zone temperature warnings shall be provided as follows for each fan coil unit:
      a. High Zone temperature: If the zone is above setpoint by an adjustable, user defined margin. Initial margin setting: 5 deg F.
      b. Low Zone Temperature: If the zone is below setpoint by an adjustable, user defined margin. Initial margin setting: 10 deg F.
   3. Zone overrides
      a. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. Initial override time 2 hours. At the expiration of this time, the control of the unit shall automatically return to the schedule.
   4. Unit alarms shall include:
      a. Unit Failure: Commanded on, but status is off
      b. Unit in Hand: Commanded off, but status is on
c. Unit in manual override

D. Operator Station Display: Indicate the following on operator workstation display terminal for each fan coil unit:

1. DDC system graphic
2. DDC system on-off indication
3. DDC system occupied/unoccupied mode
4. Room temperature indication
5. Room temperature set point
6. Zone occupied status
7. Unit on-off indication
8. Condensing unit alarms (from unit controls and per condensing unit)
9. Unit Alarms shall include:
   a. Unit Failure: Commanded on, but status is off
   b. Unit in Hand: Commanded off, but status is on
   c. Unit in manual override

3.12 EXHAUST FAN CONTROL

A. Exhaust Fan and Damper Alarms: Typical of all Exhaust Fans

1. Damper Failure: Commanded open, but status is closed.
2. Damper in Hand: Commanded closed, but status is open.
3. Fan Failure: Commanded on, but status is off
4. Fan in Hand: Commanded off, but status is on
5. Fan Status shall be reported to the BAS.

B. Exhaust fan Control (General Exhaust – Toilets, Elevators, and Custodial Closets)

1. The exhaust fans provide toilet room, elevator machine room and custodial closet exhaust ventilation.
2. The exhaust fans shall be operated continuously whenever associated AHU is occupied and shall be off whenever associated AHU is unoccupied.
3. A two-position motor-operated damper near the duct connection to the relief louver shall open whenever the fan is operating and shall be closed whenever the fan is off. The damper operator shall be electronic and operated with a low-voltage signal.
4. A damper end switch shall be provided. The exhaust fan shall not engage until the position of the end switch indicates that the damper is fully open. When the exhaust fan is disengaged, the motor operated damper shall not close until a 30 second (adjustable) time delay has elapsed, allowing the fan to decelerate.

C. Exhaust fan Control (General Exhaust – Valade)

1. The exhaust fans provide toilet room and dressing room exhaust ventilation.
2. Each exhaust fan shall be operated according to separate, user defined schedule.
3. A two-position motor-operated damper near the duct connection to the relief louver shall open whenever the fan is operating and shall be closed whenever the fan is off. The damper operator shall be electronic and operated with a low-voltage signal.
4. A damper end switch shall be provided. The exhaust fan shall not engage until the position of the end switch indicates that the damper is fully open. When the exhaust fan is disengaged, the motor operated damper shall not close until a 30 second (adjustable) time delay has elapsed, allowing the fan to decelerate.

D. Exhaust Fan Control (Paint Booth Exhaust)

1. The exhaust fan provides process exhaust for the Paint Booth.
2. The exhaust fan shall be operated by a manual two position switch located within 48” of the exhaust hood.
3. Manual switch, associated power and interlock wiring shall be provided by Division 26.
4. Provide a plastic laminate sign per Division 23 section “Identification for HVAC Piping and Equipment” with the following text:
a. Paint Booth Exhaust.
5. A two-position motor-operated damper at the exhaust louver shall be open whenever the fan is operating and shall be closed whenever the fan is off. The damper operator shall be electronic and operated with a low-voltage signal.

E. Exhaust Fan Control (Dye Vat Exhaust)
1. The exhaust fan provides process exhaust for the dye vat kettle exhaust hood.
2. The exhaust fan shall be operated by a manual two position switch located within 48” of the exhaust hood.
3. Manual switch, associated power and interlock wiring shall be provided by Division 26.
4. Provide a plastic laminate sign per Division 23 section “Identification for HVAC Piping and Equipment” with the following text:
   a. Power switch for dye vat exhaust fan. Fan must be on whenever dye vat is in use.
5. A two-position motor-operated damper in the fan inlet duct shall open whenever the fan is operating and shall be closed whenever the fan is off. The damper operator shall be electronic and operated with a low-voltage signal.

F. Exhaust Fan Control (Catering).
1. The exhaust fan is a general exhaust fan for the catering area.
2. The exhaust fan shall operate continuously, whenever associated AHU supply fans are running.
3. A motor-operated damper shall open whenever the fan is started, and shall close whenever the fan is stopped.
4. Local override: A timed local override control shall allow an occupant to operate the fan at full flow (Adj) for an adjustable period of time. Initial override time 1 hour. At the expiration of this time, the exhaust fan return to normal operation.
   a. Provide local exhaust fan indicator light (green) in local override switch cover plate. Light shall be on whenever exhaust fan is on.
   b. Provide a plastic laminate sign per Division 23 section “Identification for HVAC Piping and Equipment” with the following text: Vent fan indication.
   c. Switch, associated power and interlock wiring shall be provided by Division 23.
5. Fan Schedule Control Override
   a. Contractor shall create functionality for exhaust fan to be controlled by programmable yearly schedule – one yearly schedule per zone. In this control mode,
   b. Fan schedule control functionality shall be manually turned on and off by building operator.

3.13 DUST COLLECTOR CONTROL

A. Factory hardware and software shall enable building management system to monitor, and display dust collector status and alarms. Refer to Division 23 Section “Dust Collectors.” All associated interlock wiring, relays, and other components required connect factory installed hardware to building management system shall be provided by Division 23. Confirm the best method of status and alarm monitoring with the dust collector manufacturer.

B. Dust collector shall be operated by a manual two position switch on the wall of the Scene Shop with a plastic laminate sign per Division 23 section “Identification for HVAC Piping and Equipment” with the following text: Dust Collector Operation.

C. All associated power and interlock wiring, relays, and other components required to provide interlock shall be provided by Division 23.

D. Provide pressure drop alarm messages listed below with adjustable setpoints to BAS. Initial setpoints per manufacturer’s recommendations.
   1. Low pressure drop
   2. High pressure drop alarm

E. Performance override: A toggle switch controlled by the building automation system at the operator workstation shall allow for the exhaust fan to be disabled during scheduled performances.
F. Operator Station Display: Indicate the following on operator workstation display terminal for the dust collector:
   1. DDC system graphic
   2. DDC system on-off indication
   3. Fan on-off indication
   4. Filter pressure drop
   5. Low pressure drop alarm setpoint
   6. High pressure drop alarm setpoint
   7. Low cleaning pressure drop setpoint
   8. High cleaning pressure drop setpoint
   9. Warning: Pressure drop within 0.2” w.c. of low cleaning pressure drop setpoint
   10. Warning: Pressure drop within 0.2” w.c. of high cleaning pressure drop setpoint
   11. Warning: Pressure drop at or below low pressure drop alarm setpoint
   12. Alarm: Pressure drop at or above high pressure drop alarm setpoint
   13. Alarm: Fan or belt failure (fan commanded on, but no airflow)

3.14 AIR TERMINAL UNIT OPERATING SEQUENCE

A. General
   1. Air terminal units shall be controlled automatically through the local direct digital control panels using PI and PID control methods. Sensing elements and valve operators shall be electronic types. Safety and limit controls shall utilize local electric or electronic control loops.
   2. Pressure Independent Control: Airflow measuring sensors at the air terminal unit inlet shall provide a signal to control the unit airflow proportionally between the minimum and maximum CFM set points regardless of upstream duct pressure.
   3. Heating water control valves shall be fully modulating electrically operated two-way throttling valves, normally open, unless otherwise indicated on the Drawings.

B. Shutoff VAV Unit Control
   1. A low-voltage space temperature sensor shall provide a signal to proportionally position the unit damper from minimum (zero) to maximum airflow to provide cooling to maintain the space temperature.
   2. Initial cooling set point 75°F.

C. Constant-Volume, Terminal Air Units, Hydronic
   1. Electronic sensor will indicate space temperature, the control system will modulate the damper to maintain scheduled airflow. A normally open, heating control valve will modulate to maintain the space temperature set point.
      a. Initial space temperature set points
         1) Occupied Temperature (cooling): 75 degrees F
         2) Occupied Temperature (heating): 72 degrees F
         3) Unoccupied Temperature (cooling): 78 degrees F
         4) Unoccupied Temperature (heating): 65 degrees F

D. Variable Air Volume Terminal Air Units with Hydronic Heating Coils
   1. Electronic space temperature sensor and DDC system will modulate damper and valve to maintain space temperature set point; sequence damper from full open to minimum position, then valve from closed to fully open.
      a. Initial space temperature set points
         1) Occupied Temperature (cooling): 75 degrees F
         2) Occupied Temperature (heating): 72 degrees F
         3) Unoccupied Temperature (cooling): 78 degrees F
         4) Unoccupied Temperature (heating): 65 degrees F
   2. Dual-Max VAV Control
      a. VAV air terminal units may utilize dual-max VAV control. An operator selectable option shall allow for separate VAV control sequence and control cooling and heating minimums to the values listed below:
1) Initial cooling minimum airflow setpoint is 20% of cooling max airflow.
2) Initial heating minimum airflow setpoint is 50% of cooling max airflow.

E. Carbon Dioxide Control
1. Variable air volume terminal units with carbon dioxide sensors shall modulate towards full open whenever associated air handling maximum CO2 level is exceeded. Reheat coil shall modulate to maintain space temperature.
   a. Alarm condition shall occur whenever space carbon dioxide setpoint is exceeded for more than 60 minutes (adj.)
   b. Initial setpoint: 1300 ppm.

F. Occupancy Sensor Control
1. In spaces with lighting provided occupancy/vacancy sensors, the BAS contractor shall interface to auxiliary contacts to monitor space occupancy status.
2. BAS shall modulate unit from unoccupied to occupied setpoints whenever space occupancy/vacancy controller detects occupancy. Units shall return to unoccupied status after 30 minutes of inactivity (adj.).
3. Occupancy sensor control functionality shall be manually turned on and off per zone by building operator and operation return to default schedule control.
4. Refer to electrical drawings for occupancy and vacancy sensor locations.
5. It is the responsibility of the Div 23 contractor for all wiring and interface to auxiliary contacts for connection to occupancy and vacancy sensors provided by others.

G. Additional alarms
1. Provide the following additional alarms:
   a. Alarm: High discharge temperature alarm. Provide an alarm to indicate that the discharge air temperature off of a terminal unit exceeds an adjustable high limit. Initial setpoint 100 deg F.
   b. Alarm: High room temperature alarm. Room temperature exceeds setpoint by 5 degrees F (adjustable).
   c. Alarm: Low room temperature alarm. Room temperature is lower than setpoint by 5 degrees F (adjustable).
   d. Critical zone temperature alarms shall be provided as follows for each critical zone:
      1) High Zone temperature: If the zone is above setpoint by an adjustable, user defined temperature. Initial high temperature zone alarm: 73 deg F.
      2) Low Zone Temperature: If the zone is below setpoint by an adjustable, user defined temperature. Initial low temperature zone alarm: 67 deg F.

3.15 HYDRONIC TERMINAL UNIT CONTROL
A. General.
1. Hydronic terminal units shall be controlled with local electronic controls, except as otherwise noted.

B. Finned Tube Radiation Control.
1. Finned Tube Radiation shall be controlled by one of two sequences:
   a. The BAS shall modulate each finned tube radiation heating water control valve to maintain the zone temperature setpoint.
   b. A second radiation sequence shall be utilized to operate fin tube radiation based on outdoor air temperature.
      1) Provide outdoor air linear fin tube radiation operation. Whenever outdoor air temperature is 30 deg F, fin tube control valves shall open to minimum position. Initial minimum position is 30% open. Fin tube control valve shall be at full open at 5 deg F.
      2) Space temperature sensor shall modulate the control valve open further if space setpoint is not satisfied.
      3) If space room temperature is two degrees (adj) above setpoint, fin tube radiation outdoor air sequence shall be over-ridden and control valve shall modulate closed.
2. Outdoor air temperature fin tube sequence control functionality shall be programmed to be manually turned on and off per zone by building operator and operation return to control (toggle switch on BAS).

3. Provide operator selectable function where finned tube radiation shall be prevented from operating whenever the outside air temperature is above 50 deg F (adj)

C. Operator Station Display: Indicate the following on operator workstation display terminal:
   1. DDC system graphic.
   2. DDC system on-off indication.
   3. DDC system occupied/unoccupied mode.
   4. Room/area served.
   5. Room occupied/unoccupied.
   6. Room temperature.
   7. Room temperature set point, heating.
   8. Room temperature set point, cooling.
   9. Room temperature set point, occupied.
  10. Room temperature set point, unoccupied.
  11. Air-damper position as percent open.
  12. Control-valve position as percent open.
  13. Duct mounted reheat coil discharge temperature.
  14. Alarm: High discharge temperature alarm. Provide an alarm to indicate that the discharge air temperature off of a terminal unit exceeds an adjustable high limit. Initial setting is 100 degrees F.
  15. Alarm: High room temperature alarm. Room temperature exceeds setpoint by 5 degrees F.
  16. Alarm: Low room temperature alarm. Room temperature is lower than setpoint by 5 degrees F.

3.16 UNIT HEATER CONTROL SEQUENCES

A. Electric Unit Heaters
   1. Manufacturer controls shall modulate the electric unit heaters to maintain space temperature.
   2. The DDC system shall monitor unit status and an electronic space temperature sensor shall monitor space temperature set point.
   3. Initial set point 68°F.
   4. Display:
      a. DDC system graphic
      b. Unit status (on/off)
      c. Room temperature indication
      d. Control valve position
      e. Occupancy status
      f. Alarm: Low room temperature alarm.

B. Hydronic Unit Heaters
   1. Electronic space temperature sensor and controller will cycle fan and two-position normally-open control valve to maintain space temperature set point.
   2. Display:
      a. DDC system graphic
      b. Unit status (on/off)
      c. Room temperature indication
      d. Room temperature set point
      e. Control valve position
      f. Occupancy status
      g. Alarm: Low room temperature alarm. Room temperature is lower than setpoint by 5 degrees F (adjustable).

3.17 FAN COIL UNIT CONTROL

A. General.
1. Unit includes a supply fan, chilled water cooling coil, hot water heating coil, and air filters.
2. Unit is a constant volume, variable temperature type which provides space heating and cooling.
3. The air unit shall be controlled automatically through local direct digital control panels using PI and PID control methods. Safety and limit controls shall utilize local electric control loops.
4. Unit shall be interlocked via DDC to start and stop.

B. Supply Fan Control
1. The unit shall run according to a user definable time schedule in the following modes:
   a. Occupied mode: The unit shall maintain:
      1) A 74 deg F cooling zone setpoint (adjustable)
      2) A 70 deg F heating zone setpoint (adjustable)
   b. Unoccupied Mode:
      1) An 80 deg F cooling zone setpoint (adjustable)
      2) A 60 deg F heating zone setpoint (adjustable)
   c. Fan coil units serving elevator, mechanical, electrical, telecommunications, and audio equipment rooms shall run continuously, as needed for space cooling.
2. Fan Alarms shall include:
   a. Fan Failure: Commanded on, but status is off
   b. Fan in Hand: Commanded off, but status is on
   c. Unit in manual override
3. For fan coils with VFDs, modulate the fan speed and coil valve positions in sequence to maintain space temperature.
4. Zone Unoccupied override
   a. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. Initial override time 2 hours. At the expiration of this time, the control of the unit shall automatically return to the schedule.
5. Unit Supply-Air Fan Operation:
   a. Occupied Periods: Fan runs continuously.
   b. Unoccupied Periods: Fan cycles to maintain room setback temperature.

C. Hydronic-Cooling-Coil Operation:
1. Occupied Periods: Modulate control valve to maintain room temperature.
2. Unoccupied Periods: Close control valve.
3. The cooling coil control valve shall be a two-way modulating valve, normally open (fail open).

D. Heating-Coil Operation:
1. Occupied Periods: Modulate control valve to provide heating if room temperature falls below thermostat set point.
2. Unoccupied Periods: Start fan and modulate control valve if room temperature falls below setback temperature.
3. The heating coil control valve shall be a two-way modulating valve, normally open.

E. Outdoor-Air Damper Operation (Outdoor Temperature Based Economizer):
1. Sequence for fan coil units with outdoor air connections.
2. Occupied Periods:
   a. Outdoor-Air Temperature below Room Temperature: If room temperature is above set point and the Outdoor Air temperature is below the supply air temperature set point, modulate outdoor-air damper to maintain supply air temperature at setpoint (adjustable - initially 55 degrees F) (outdoor-air economizer).
      1) If room temperature is below set point, close outdoor air damper.
   b. Outdoor-Air Temperature above Supply Temperature set point: Close outside air damper. Modulate coil valves to maintain room temperature at set point.
   c. Modulate return/relief damper(s) equal and opposite the outside air damper.
3. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
F. Operator Station Display: Indicate the following on operator workstation display terminal for each fan coil unit:
   1. DDC system graphic.
   2. DDC system on-off indication.
   3. DDC system occupied/unoccupied mode.
   4. Room temperature indication.
   5. Room temperature set point.
   6. Zone occupied status
   7. Cooling coil control-valve position.
   8. Heating coil control valve position
   9. Outside air damper position (units with air side economizer).
  10. Return air damper position (units with air side economizer)
  11. Relief air damper position
  12. Supply air temperature
  13. Fan on-off indication
  14. Filter differential pressure
  15. Filter change advisory message: Filter differential pressure exceeds adjustable setpoint. Initial setpoint 0.5 in. w.g.
  16. Alarm: High supply air temperature (Temperature over an adjustable setpoint. Initial setpoint 105° F.)
  17. Alarm: Low supply air temperature (Temperature below an adjustable setpoint. Initial setpoint: 48° F)
  18. Zone temperature alarms shall be provided as follows for each fan coil unit:
      a. High Zone temperature. If the zone is above setpoint by an adjustable, user defined margin. Initial margin setting: 6 deg F.
      b. Low Zone Temperature. If the zone is below setpoint by an adjustable, user defined margin. Initial margin setting: 5 deg F.
  19. Unit discharge air temperature alarms
      a. Low discharge air temperature. If the unit discharge air temperature is below 50 deg F (adjustable).
  20. Fan Alarms shall include:
      a. Fan Failure: Commanded on, but status is off
      b. Fan in Hand: Commanded off, but status is on
      c. Unit in manual override

3.18 LOCAL HUMIDIFIER CONTROL

A. General
   1. Packaged humidifier unit with self-contained controls.
   2. The unit shall be controlled automatically through the local packaged controls but shall additionally be addressable and monitored on the DDC.
   3. The unit shall be interlocked through the DDC to start and stop.

B. Whenever there is a call for room humidification, the local fan coil unit fan shall be at full flow. On a call for room humidification, the building automation system engage the associated fan coil unit to operate fan at full flow condition. Provide user adjustable humidifier delays and additional fan runtime when humidity setpoints are met.

C. Provide separate room RH sensor, located remotely from the humidifier unit, not closer than 10’ from the humidifier.

D. Whenever room relative humidity exceeds high humidity alarm, the humidifier shall be staged off.

E. Operator Station Display: Indicate the following on operator workstation display terminal for each wall mounted electronic humidifier:
   1. DDC system graphic.
   2. DDC system on-off indication.
   3. DDC system occupied/unoccupied mode.
4. Room/area served.
5. Space temperature
6. Space temperature setpoint
7. Space relative humidity – measured at humidifier
8. Space relative humidity – measured at remote RH sensor
9. Space relative humidity setpoint
11. Alarm: High humidity (Humidity above adjustable setpoint. Initial setpoint: 60% RH.)
12. Alarm: Low humidity (Humidity below adjustable setpoint: Initial setpoint: 30% RH.)
13. Alarm: Low water level

3.19 OUTSIDE AIR CONDITIONS

A. The BAS shall monitor and display the outside air temperature and humidity and calculate the outside air enthalpy on a continual basis. These values shall be made available to the system at all times.

B. Outside Air Temperature and Humidity History
1. The BAS shall monitor and record the high and low temperature and humidity readings for the outside air. These readings shall be recorded on a daily, month-to-date, and year-to-date basis.

C. Cooling Degree Day History
1. The BAS shall provide a Degree Day history index that reflects the energy consumption for the facility cooling demand. Computations shall use a mean daily temperature of 65 deg. F (adjustable). The Degree Day peak value readings shall be recorded on a daily, month-to-date, and year-to-date basis.

D. Heating Degree Day History
1. The BAS shall provide a Degree Day history index that reflects the energy consumption for the facility cooling demand. Computations shall use a mean daily temperature of 65 deg. F (adjustable). The Degree Day peak value readings shall be recorded on a daily, month-to-date, and year-to-date basis.

E. Sensor failure alarm: Sensor reading indicates shorted or disconnected sensor.

F. Additional alarms
1. Provide the following additional alarms:
   a. Alarm: Sensor failure: Sensor reading indicates shorted or disconnected sensor

3.20 VARIABLE FREQUENCY DRIVE (VARIABLE SPEED DRIVE) MONITORING INTERFACE

A. Provide monitoring of current VFD(VSD) status and operating conditions through the drive BACNet communications interface port.

B. Operator Station Display: Indicate the following on operator workstation display terminal:
1. DDC system graphic.
2. DDC system on-off indication.
3. DDC system occupied/unoccupied mode.
4. Drive number and motor served
5. Motor speed (RPM)
6. Motor frequency (Hz)
8. Motor run time
9. VFD status
10. Alarm the following conditions:
    a. Motor overspeed condition
    b. Motor overcurrent condition
    c. VFD Fault
3.21 POWER MONITORING AND REPORTING

A. The BAS shall meter, monitor and record each of the points below. The contractor must refer to the electrical one-line diagram E010, generator and transfer switch specifications, and panelboard schedules to for additional information.

1. Generator power from generator controller.
   a. kW demand
   b. kVA demand
   c. kWh

2. Air Cooled Chiller power consumption

3. Air Handling Unit power consumption (aggregated from VFDs)

4. System hot water system flow rate (gpm)

5. System hot water supply and return water temperature

6. System hot water btu consumption (calculated)

7. System chilled water system flow rate (gpm)

8. System chilled water supply and return water temperature

9. System chilled water btu consumption (calculated)

10. Outdoor-air temperature

11. Outdoor-air relative humidity

12. Daily, month to date, and year to date high outdoor-air temperature

13. Daily, month to date, and year to date low outdoor-air temperature

14. Daily, month to date, and year to date cooling degree days

15. Daily, month to date, and year to date heating degree days

B. Monitoring Information

1. The BAS shall monitor and record the peak (high and low) demand readings from the meters.

2. The readings shall be taken at no less than 15 minute intervals.

3. These readings shall be recorded on a daily, month-to-date, and year-to-date basis.

C. It is the responsibility of the temperature controls contractor to obtain information from shop drawings, other trades, etc. to confirm meter points information. Notify Engineer immediately if information needed for metering is not available.

D. Generate and transmit reports of the monitoring points and data listed above. The reports shall be generated and emailed every month (adjustable) to a list of members identified by the Owner.

E. History and Frequency: The readings shall be taken at no less than 15 minute intervals, and shall be logged, trended and stored for no less than one year. These readings shall also be recorded on a daily, month-to-date, and year-to-year basis. Once a month, data shall be automatically exported to CSV file and saved on the network and operator station. Coordinate file saving and naming conditions with the Bowdoin facilities, Commissioning authority and Engineer.

F. Refer to both Division 22, 23 and 26 for additional information regarding metering and monitoring. It is the responsibility of the temperature controls contractor to obtain information from shop drawings, other trades, etc. and develop calculated performance information. Notify Engineer immediately if information needed for calculation is not available.

3.22 LOSS OF POWER

A. The BAS shall monitor main building power status. Upon loss of power, the system shall provide a high-priority alarm. The high-priority alarm shall be configured to communicate with specific communication protocols (ie emails, texts, etc.) and to specific groups identified by the owner. Coordinate specific requirements with owner, commissioning authority, and engineer.

1. It is the responsibility of the Division 23 contractor to provide all necessary monitoring devices and necessary potential transformer, current transducers, wiring, accessories, etc. of the main building power status by monitoring the automatic transfer switch, generator, or provide
B. Upon loss of power, the BAS shall have a UPS system (provided by DIV 23) that shall maintain all building automation system programming, reporting, and control functionality only (not equipment power, just control power). UPS shall be able to power BAS system and maintain all programming, data, etc. for a minimum of 4 hours of complete loss of power.

1. In addition to maintaining the main BAS system, it is the responsibility of the controls contractor that the building automation system and associated UPS shall maintain all functionality of mechanical systems and associated controllers tied to the generator. Equipment and systems that need to be functional are identified in EM800 series of electrical drawings.

C. Emergency Generator Interface

1. The control contractor shall coordinate communication protocol with Division 26 to provide a communications interface with the generator and alternate critical mechanical systems generator with the BAS.

2. Coordinate with the emergency generator vendor(s) to obtain system points list to map appropriate points to be monitored through the BAS.

3.23 SUMP PUMP MONITORING

A. Refer to Division 22 Sections “Sump Pumps” for a description of the automatic control sequence for the sump pump.

B. Interface with sump pump motor control panel located near pump control panel to monitor the following:

1. Pump motor on-off status (one each)
2. Alarm (one each)

3.24 DOMESTIC WATER HEATER CONTROL

A. Refer to Division 22 Sections “Domestic Water Heaters” and “Domestic Water Pumps” for a description of the automatic control sequence for the domestic water heaters and domestic water circulating pumps.

B. Interface to the domestic hot water heaters to provide monitoring, control and setpoint adjustment of the following:

1. Domestic water supply temperature setpoint
2. Domestic water supply temperature
3. Heater on-off indicator (one for each hot water heater)
4. Heater alarm (one for each hot water heater)
5. Pump on-off indicator

3. Provide the following alarms:
   a. High water temperature: If water supply temperature is greater than an adjustable setpoint.
   b. Heater Failure: If water supply temperature is lower than an adjustable setpoint.
   c. Pump Failure: If pump is commanded on, and status is off.

3.25 MISCELLANEOUS

A. The BAS shall monitor the following:

1. Emergency generator status (alarm)
2. Emergency generator fault (alarm)
3. Piano Storage Room condensate drain pan water sensor (alarm)

B. Override Reporting

1. Create and provide a report of all sequences, settings, setpoints, etc. that are operating in an override mode (non-automatic function). Report shall include associated system, equipment
name, and date of change. Report shall be created upon a single request command by the building operator.

END OF SECTION
SECTION 231123
FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Pipes, tubes, and fittings.
      2. Piping specialties.
      3. Piping and tubing joining materials.
      4. Valves.
      5. Pressure regulators.
      7. Concrete bases.

1.3 DEFINITIONS
   A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
   B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
   C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
   D. Low Pressure Gas System (LPG): Systems that operate at pressures not exceeding 14-inches water column.
   E. Medium Pressure Gas System (MPG): Systems that operate at pressures greater than 14-inches water column and not greater than 5 psig.
   F. High Pressure Gas System (HPG): Systems that operate at pressures greater than 5-psig.

1.4 PERFORMANCE REQUIREMENTS
   A. Minimum Operating-Pressure Ratings:
      1. Piping and Valves: 125 psig minimum unless otherwise indicated.
      2. Service Regulators: 65 psig minimum unless otherwise indicated.
      3. Minimum Operating Pressure of Service Meter: 5 psig – verify with local utility requirements.
   B. Natural-Gas System Pressure: More than 0.5 psig but not more than 2 psig.

1.5 ACTION SUBMITTALS
   A. Product Data: For each type of the following:
      1. Piping specialties.
      2. Corrugated, stainless-steel tubing with associated components.
      3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
      4. Pressure regulators. Indicate pressure ratings and capacities.
5. Service meters. Indicate pressure ratings and capacities. Include bypass fittings and meter bars and supports.
6. Dielectric fittings.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
   1. Shop Drawing Scale: 1/4 inch per foot.
   2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

1.6 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities
C. Welding certificates.
D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For motorized gas valves, pressure regulators, and service meters to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE
A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
D. Protect stored PE pipes and valves from direct sunlight.

1.10 PROJECT CONDITIONS
A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

1.11 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided.
B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 “Access Doors and Frames.”

PART 2 PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      b. End Connections: Threaded or butt welding to match pipe.
      c. Lapped Face: Not permitted underground.
      e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
   5. Mechanical Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Dresser Piping Specialties; Division of Dresser, Incorporated. (www.dresser.com)
         2) Smith-Blair, Incorporated. (www.smith-blair.com)
      b. Steel flanges and tube with epoxy finish.
      c. Buna-nitrile seals.
      d. Stainless-steel bolts, washers, and nuts.
      e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
      f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

B. PE Pipe: ASTM D 2513, SDR 11.
   1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
   2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
      a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
      b. Outlet shall be threaded or flanged or suitable for welded connection.
      c. Bridging sleeve over mechanical coupling.
      d. Factory-connected anode.
      e. Tracer wire connection.
      f. Ultraviolet shield.
      g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
   4. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         2) Mueller Company; Gas Products Division (www.muellercompany.com)
      b. PE body with molded-in, stainless-steel support ring.
c. Buna-nitrile seals.
d. Acetal collets.
e. Electro-zinc-plated steel stiffener.

5. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      2) Mueller Company; Gas Products Division (www.muellercompany.com)
   b. Fiber-reinforced plastic body.
c. PE body tube.
d. Buna-nitrile seals.
e. Acetal collets.
f. Stainless-steel bolts, nuts, and washers.

6. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Dresser Piping Specialties; Division of Dresser, Incorporated. (www.dresser.com)
      2) Smith-Blair, Incorporated. (www.smith-blair.com)
   b. Stainless-steel flanges and tube with epoxy finish.
c. Buna-nitrile seals.
d. Stainless-steel bolts, washers, and nuts.
e. Factory-installed anode for steel-body couplings installed underground.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
   2. Corrugated stainless-steel tubing with polymer coating.
   3. Operating-Pressure Rating: 0.5 psig.
   5. Threaded Ends: Comply with ASME B1.20.1.
   6. Maximum Length: 72 inches

B. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.


C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.
2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 125 psig.
   3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
   6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
   1. CWP Rating: 125 psig.
   2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BrassCraft Manufacturing Company; a Masco company. (www.brasscraft.com)
      b. Conbraco Industries, Incorporated; Apollo Division (www.apollovalves.com)
   3. Ball: Chrome-plated bronze.
   4. Stem: Bronze; blowout proof.
   5. Seats: Reinforced TFE; blowout proof.
   6. Packing: Threaded-body pack nut design with adjustable-stem packing.
   8. CWP Rating: 600 psig.
   9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Lee Brass Company. (www.leebrass.com)
   5. Operator: Square head or lug type with tamperproof feature where indicated.
   6. Pressure Class: 125 psig.
   7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Non-lubricated Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Mueller Company; Gas Products Division (www.muellercompany.com)
   c. Xomox Corporation; a Crane company. (www.cranechempharma.com)

2. Body: Cast iron, complying with ASTM A 126, Class B.

3. Plug: Bronze or nickel-plated cast iron.

4. Seat: Coated with thermoplastic.

5. Stem Seal: Compatible with natural gas.


7. Operator: Square head or lug type with tamperproof feature where indicated.

8. Pressure Class: 125 psig.

9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flowserve. (www.flowserve.com)
   b. Homestead Valve; a division of Olson Technologies, Incorporated (www.homesteadvalve.com)
   d. Milliken Valve Company. (www.millikenvalve.com)
   e. Mueller Company; Gas Products Division (www.muellercompany.com)

2. Body: Cast iron, complying with ASTM A 126, Class B.

3. Plug: Bronze or nickel-plated cast iron.

4. Seat: Coated with thermoplastic.

5. Stem Seal: Compatible with natural gas.


7. Operator: Square head or lug type with tamperproof feature where indicated.

8. Pressure Class: 125 psig.

9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

H. PE Ball Valves: Comply with ASME B16.40.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Kerotest Manufacturing Corporation (www.kerotest.com)

2. Body: PE.

3. Ball: PE.


5. Seats and Seals: Nitrile.

6. Ends: Plain or fusible to match piping.

7. CWP Rating: [80 psig].

8. Operating Temperature: [Minus 20 to plus 140 degrees F].

9. Operator: Nut or flat head for key operation.

10. Include plastic valve extension.

11. Include tamperproof locking feature for valves where indicated on Drawings.

I. Valve Boxes:

1. Cast-iron, two-section box.

2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ASCO Power Technologies, LP; Division of Emerson. (www.ascovalve.com)
      b. Dungs, Karl, Incorporated (www.dungs.com)
      c. Eaton Corporation; Controls Division (www.eaton.com)
      d. Eclipse Combustion, Incorporated (www.eclipsenet.com)
      e. Honeywell International Incorporated (www.honeywell.com)
      f. Johnson Controls. (www.johnsoncontrols.com)

2. Body: Brass or aluminum.
5. Normally closed.
7. Electrical operator for actuation by appliance automatic shutoff device.

B. Electrically Operated Valves: Comply with UL 429.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ASCO Power Technologies, LP; Division of Emerson. (www.ascovalve.com)
      b. Dungs, Karl, Incorporated (www.dungs.com)
      c. Eclipse Combustion, Incorporated (www.eclipsenet.com)
      d. Magnatrol Valve Corporation. (www.magnatrol.com)
      e. Parker Hannifin Corporation; Parflex Division. (www.parker.com)
      f. Watts Regulator Co.; Division of Watts Water Technologies, Inc. (www.watts.com)

2. Pilot operated.
3. Body: Brass or aluminum.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.

2.6 PRESSURE REGULATORS

A. General Requirements:
   1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Fisher Control Valves and Regulators; Division of Emerson Process Management. (www2.emersonprocess.com)
      b. Invensys. (www.invensys.com)
      c. Itron Incorporated (www.itron.com/)
d. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Actaris.
   b. American Meter Company.
   c. Eclipse Combustion, Incorporated (www.eclipsenet.com)
   d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   e. Invensys. (www.invensys.com)
   f. Maxitrol Company.
   g. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 5 psig.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Canadian Meter Company Incorporated (www.elster.com)
   b. Eaton Corporation; Controls Division (www.eaton.com)
   c. Harper Wyman Company
   d. Maxitrol Company. (www.maxitrol.com)
   e. SCP, Incorporated
5. Seat Disc: Nitrile rubber.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.7 DIELECTRIC FITTINGS
A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
B. Dielectric Flanges:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Central Plastics Company. (www.centralplastics.com)
      b. Watts Regulator Co.; Division of Watts Water Technologies, Inc. (www.watts.com)
      c. Wilkins; a Zurn company.
   2. Description:
      b. Factory-fabricated, bolted, companion-flange assembly.
      c. Pressure Rating: 150 psig.
      d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
C. Dielectric-Flange Insulating Kits:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Calpico, Incorporated (www.calpicoinc.com)
      c. Central Plastics Company. (www.centralplastics.com)
      d. Pipeline Seal and Insulator, Incorporated (www.pipelineseal.com)
   2. Description:
      a. Non-conducting materials for field assembly of companion flanges.
      b. Pressure Rating: 150 psig.
      c. Gasket: Neoprene or Phenolic.
      d. Bolt Sleeves: Phenolic or polyethylene.
      e. Washers: Phenolic with steel backing washers.

2.8 LABELING AND IDENTIFYING
A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 EXECUTION
3.1 EXAMINATION
A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION
A. Inspect natural-gas piping according to NFPA 54 and the Michigan Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

3.3 VALVE INSTALLATION
A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
B. Install underground valves with valve boxes.
C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
D. Install anode for metallic valves in underground PE piping.

3.4 PIPING JOINT CONSTRUCTION
A. Ream ends of pipes and tubes and remove burrs.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Threaded Joints:
   1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   2. Cut threads full and clean using sharp dies.
   3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
   4. Apply appropriate tape or thread compound to external pipe threads unless Dryseal threading is specified.
   5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
D. Welded Joints:
   2. Bevel plain ends of steel pipe.
   3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not over-tighten.
H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.5 HANGER AND SUPPORT INSTALLATION
A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
   5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.
3.6 CONNECTIONS
A. Connect to utility's gas main according to utility's procedures and requirements.
B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
C. Install piping adjacent to appliances to allow service and maintenance of appliances.
D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.7 LABELING AND IDENTIFYING
A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.
B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below sub grade under pavements and slabs.

3.8 PAINTING
A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.
B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
   1. Alkyd System: MPI EXT 5.1D.
      c. Topcoat: Exterior alkyd enamel flat.
      d. Color: Gray.
C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.9 FIELD QUALITY CONTROL
A. Perform tests and inspections.
B. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to NFPA 54 and the Michigan Fuel Gas Code and authorities having jurisdiction.
C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.10 PIPING SCHEDULE
A. Aboveground natural-gas piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.

3.11 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE
A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.

B. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.

C. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:
   1. Bronze plug valve.
   2. Cast-iron, lubricated plug valve.

D. Valves in branch piping for single appliance shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes pipe and fitting materials and joining methods for the following:
      1. Hot-water heating piping.
      2. Chilled-water piping.
      3. Makeup-water piping.
      4. Condensate-drain piping.
      5. Air-vent piping.

1.3 ACTION SUBMITTALS
   A. Delegated-Design Submittal:
      1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
      2. Locations of pipe anchors and alignment guides and expansion joints and loops.
      3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
      4. Locations of and details for penetration and fire-stopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.4 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
      1. Suspended ceiling components.
      2. Other building services.
      3. Structural members.
   B. Field quality-control reports.
   C. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE
   A. Installer Qualifications:
   B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
      2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.6 COORDINATION

A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate pipe sleeve installations for foundation and exterior wall penetrations. Coordinate with requirements specified in Division 7 Sections for sealing pipe penetrations through exterior and foundation walls.

C. Coordinate pipe fitting pressure classes with products specified in related Sections.

D. Coordinate power requirements for hydronic specialties with Division 26 installer.

E. Coordinate the installation of hydronic control devices with Section 230900 "Instrumentation and Controls for HVAC".

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 125 psig at 200 degrees F.
2. Chilled-Water Piping: 125 psig at 200 degrees F.
3. Makeup-Water Piping: 80 psig at 150 degrees F.
4. Condensate-Drain Piping: 150 degrees F.
5. Air-Vent Piping: 200 degrees F.
6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 NOISE CONTROL FOR MECHANICAL SYSTEMS

A. Some systems and equipment requirements may also be included in specification section 230548 "Noise Control for Mechanical Systems." Refer to both specification sections for acoustic requirements. Where specifications differ, the more stringent acoustic requirement applies.

2.3 COPPER TUBE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide copper tubing and fittings manufactured by one of the following:

- Cambridge-Lee Industries Incorporated.
- Cerro Flow Products Incorporated.
- Mueller Industries Incorporated.
- Nibco Incorporated

B. Drawn-Temper Copper Tubing: ASTM B 88, Type L

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Copper or Bronze Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   - NIBCO INC.
   - Viega.
2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200-psig working-pressure rating at 250 deg F.
2.4 STEEL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide steel pipe manufactured by one of the following:
   1. American Steel Pipe; Division of American Cast Iron Pipe Company.
   2. Central Steel and Wire Company.
   3. LaBarge Pipe and Steel Company.

B. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

C. Stainless-Steel Pipe and Fittings: Schedule 10, ASTM A 312/A 312M, Grade TP304L or TP316L, unless otherwise indicated; seamless pipe and ASTM A 403/A 403M, Class S, seamless fittings matching pipe thickness and grade, for welded joints.

D. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.


F. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

G. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

H. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

I. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   2. End Connections: Butt welding.
   3. Facings: Raised face.

J. Grooved Mechanical-Joint Fittings and Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Anvil International, Inc.
      b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
      c. National Fittings, Inc.
      d. Victaulic Company.
   2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
   3. Couplings: Ductile- or malleable-iron housing and EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

K. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

PART 3 EXECUTION

3.1 PIPE PENETRATIONS

A. HVAC, DOMESTIC WATER, SEWER, DRAIN AND VENT PIPING
   1. Where a pipe passes through a wall, ceiling or floor slab, a steel sleeve shall be cast or grouted into the structure. The internal diameter of the sleeve shall be 50mm (2") larger than the external diameter of the pipe passing through it. After all of the piping is installed in that area, the Contractor shall check the clearance and correct it, if necessary, to within 1/50mm (2"). Then the void shall be packed full depth with glass/mineral fiber and sealed at both ends, 25mm (1") deep, with sealant backed by foam rod.

3.2 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 3 and smaller, shall be any of the following:
   1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Hot-water heating piping, aboveground, NPS 4 and larger shall be the following:
   1. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. Chilled-water piping, aboveground, NPS 3 and smaller shall be the following:
   1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Chilled-water piping, aboveground, NPS 4 and larger shall be the following:
   1. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

E. Makeup-water piping installed aboveground shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

F. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

G. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
B. Install exterior underground piping and fittings according to the manufacturer’s published instructions. Provide a minimum of four feet of cover.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

M. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

N. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

P. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

Q. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

R. Install unions in steel piping, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

S. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

T. Install shutoff valve immediately upstream of each dielectric fitting.

U. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

V. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

Z. Install drain traps for each condensate drain pan for cooling coils in air handling units and fan-coil units. Provide vented water seal and terminate with a turned-down elbow at a floor drain.
   1. For roof-mounted equipment, provide drain traps with vented water seal and a turned-down elbow to discharge into the roof drain.

AA. Install drain piping for outside air and relief/exhaust air plenums, and as indicated. Provide a waste fitting on the sheet metal plenum, and extend a turned-down elbow at a floor drain. Do not trap. Do not use plastic pipe.
3.4 DIELECTRIC FITTING INSTALLATION
A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or flanges.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 HANGERS AND SUPPORTS
A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
   6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 7 feet.
   2. NPS 1: Maximum span, 7 feet.
   3. NPS 1-1/2: Maximum span, 9 feet.
   4. NPS 2: Maximum span, 10 feet.
   5. NPS 2-1/2: Maximum span, 11 feet.
   6. NPS 3 and Larger: Maximum span, 12 feet.
D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.6 PIPE JOINT CONSTRUCTION
A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
   4. PVC Non-pressure Piping: Join according to ASTM D 2855.

I. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

J. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.7 PIPES CROSSING ACOUSTIC JOINTS
A. Any pipe crossing an acoustical joint shall have a twin-sphere neoprene flexible connector at the joint, with the exception of piping associated with fire protection, gas and compressed air, and shall be suspended by Type D isolators as follows:
   1. Pipes with inner diameters less than 50mm (2") shall be suspended by Type E isolators for a minimum distance of 6m (20') on each side of the joint.
   2. Pipes with an inner diameter of 50mm (2") or greater shall be suspended on Type D isolators for a minimum distance of 6m (20') on the non-isolated structure and for the entire pipe length on the isolated structure.

3.8 TERMINAL EQUIPMENT CONNECTIONS
A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.9 CHEMICAL TREATMENT
A. Refer to HVAC Water Treatment specification for required chemical treatment.

3.10 FIELD QUALITY CONTROL
A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Clean all strainers.
4. Set makeup pressure-reducing valves for required system pressure.
5. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
6. Set temperature controls so all coils are calling for full flow.
7. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
8. Verify proper chemical treatment for each system.

END OF SECTION
SECTION 232116
HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY
A. Section includes special-duty valves and specialties for the following:
   1. Hot-water heating piping.
   2. Chilled-water piping.
   3. Dual-temperature piping.
   4. Makeup-water piping.
   5. Condensate-drain piping.
   7. Air-vent piping.
   8. Condensate Coolers

1.2 ACTION SUBMITTALS
A. Product Data: For each type of the following:
   1. Valves: Include flow and pressure drop curves based on manufacturer’s testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air-control devices.
   3. Hydronic specialties.

1.3 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS
A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flow meter, probes, hoses, flow charts, and carrying case.

1.5 QUALITY ASSURANCE
A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Hot-Water Heating Piping: 125 psig at 200 degrees F.
   2. Chilled-Water Piping: 125 psig at 200 degrees F.
   3. Makeup-Water Piping: 80 psig at 150 degrees F.
   4. Condensate-Drain Piping: 150 degrees F.
   5. Air-Vent Piping: 200 degrees F.
   6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.
2.2 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 “General-Duty Valves for HVAC Piping.” Section 15112 “General-Duty Valves for HVAC Piping.”

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 “Instrumentation and Control for HVAC.”

C. Bronze, Calibrated-Orifice, Balancing Valves:
   1. Valve sizes up to NPS 3
   2. Manufacturers: Subject to compliance with requirements, provide products by the following:
      b. Bell & Gossett Domestic Pump.
      c. Gerand Engineering Co.
      d. Tour & Andersson; available through Victaulic Company.
   3. Body: Bronze, ball or plug type with calibrated orifice or venturi.
   4. Ball: Brass or stainless steel.
   5. Plug: Resin.
   6. Seat: PTFE.
   7. End Connections: Threaded or socket.
   9. Handle Style: Lever, with memory stop to retain set position.
   11. Maximum Operating Temperature: 250 degree F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
   1. Valve sizes NPS 4 and up
   2. Manufacturers: Subject to compliance with requirements, provide products by the following:
      b. Bell & Gossett Domestic Pump.
      c. Gerand Engineering Co.
      d. Tour & Andersson; available through Victaulic Company.
   3. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
   4. Ball: Brass or stainless steel.
   5. Disc: Glass and carbon-filled PTFE.
   6. Seat: PTFE.
   7. End Connections: Flanged or grooved.
   9. Handle Style: Lever, with memory stop to retain set position.
   11. Maximum Operating Temperature: 250 degree F.

   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Amtrol, Incorporated.
      b. Armstrong Pumps, Incorporated.
      c. Bell & Gossett Domestic Pump.
      d. Conbraco Industries, Incorporated.
      f. Watts Regulator Co.
   2. Body: Bronze or brass.
   3. Disc: Glass and carbon-filled PTFE.
   5. Stem Seals: EPDM O-rings.
   6. Diaphragm: EPT.
8. Inlet Strainer: stainless steel removable without system shutdown.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Automatic Flow-Control Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   b. Griswold Controls.
   c. Nexus Valve, Incorporated.
2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly Corrosion resistant, tamper proof, self-cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
9. Maximum Operating Temperature: 250 degrees F.

2.3 FLOW MEASURING DEVICES
A. Manufacturers:
1. Calibrated Balancing Valves
   b. Bell & Gossett Domestic Pump.
   c. Gerard Engineering Co.
   d. Tour & Andersson; available through Victaulic Company.
B. Venturi:
1. Description: Differential-pressure-design flow-element.
2. Construction: Cast-brass 2-inches and smaller, (Steel 2-1/2-inches and larger) flow element body, brass nipples, brass ball valves and push-type disconnect for connection to a differential pressure meter; threaded or flanged ends.
3. Calibrated Nameplate: Chained metal tag with element size, location, G.P.M., and differential pressure at design flow condition.
4. Permanent Head Loss: Not more than 25 inches’ w.g.
7. Accuracy: Plus or minus 1.0 percent.

2.4 AIR-CONTROL DEVICES
A. Manual Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Amtrol, Incorporated.
   b. Armstrong Pumps, Incorporated.
   c. Bell & Gossett Domestic Pump.
   d. Nexus Valve, Incorporated.
   e. Taco, Incorporated.
2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 degree F.

B. Automatic Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Amtrol, Incorporated.
   b. Armstrong Pumps, Incorporated.
   c. Bell & Gossett Domestic Pump.
   d. Nexus Valve, Incorporated.
   e. Taco, Incorporated.
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
5. Inlet Connection: NPS 1/2.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 degree F.

C. Diaphragm-Type Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Amtrol, Incorporated.
   b. Armstrong Pumps, Incorporated.
   c. Bell & Gossett Domestic Pump.
   d. Taco, Incorporated.
2. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 degree F (191 degree C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
5. Each floor-mounted unit shall be supported on elastomeric pads. Each suspended unit shall be supported on Type D hangers. Where piping on isolators is connected to these units, the connection shall be made with a neoprene flexible connector.

D. Coalescing Tangential-Type Air Separators:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Bell and Gossett CRS
2. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 degree F maximum operating temperature.
3. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
4. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
5. Blowdown Connection: Threaded.
7. Each floor-mounted unit shall be supported on elastomeric pads. Each suspended unit shall be supported on Type D hangers. Where piping on isolators is connected to these units, the connection shall be made with a neoprene flexible connector.

2.5 HYDRONIC PIPING SPECIALTIES
A. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. **CWP Rating:** 125 psig.

**B. Basket Strainers:**
1. **Body:** ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. **End Connections:** Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. **Strainer Screen:** 60-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. **CWP Rating:** 125 psig.

**C. Spherical, Rubber, Flexible Connectors:**
1. **Manufacturers:** Subject to compliance with requirements, provide spherical, rubber, flexible connectors manufactured by one of the following:
   a. Mason Industries
   b. Metraflex
2. **Description**
   a. **Body:** Peroxide cured EPDM with Kevlar tire cord reinforcement. Raised face rubber flanges shall encase solid steel rings.
      1) 14-inches and smaller: Ductile-iron ring between two spheres.
      2) 16-inches through 24-inches: Single sphere
   b. **End Connections:** Steel flanges drilled to align with Classes 150 and 300 steel flanges.
   c. **CWP Rating:**
      1) 14-inches and smaller: 250 psi at 170°F; 215 psi at 250°F.
      2) 16-inches through 24-inches: 180 psi at 170°F; 150 psi at 250°F.
   d. **Maximum Operating Temperature:** 250 degrees F.

**D. Expansion Fittings:** Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping."

### 2.6 CONDENSATE COOLERS

**A. General:**
1. Device to mix hot condensate or hot water with a non-potable cold water supply to reduce the outlet temperature to an acceptable discharge drain temperature.

**B. Manufacturers:**
1. Armstrong International
2. Cemline Corporation
3. Spirax Sarco

**C. Materials**
1. **Body:** ASTM A48 Cast iron or Carbon Steel
2. **Pipe and Fittings:** Malleable iron
3. **Controller body:** Brass
4. **Sensing bulb material:** Bronze

**D. Tempered condensate outlet temperature:**
1. **Factory preset:** 135 degrees F
2. **Field adjustable:** 115 to 180 degrees F

**E. Maximum cold water pressure:** 150 psig

**F. Pre-assembled, packaged with integral flow and temperature mixing valve controls**

**G. Sizing**
1. Contractor shall size condensate cooler to accommodate the total condensate and non-potable cooling water flow within the acceptable range per the manufacturer’s written instructions.
PART 3 EXECUTION

3.1 VALVE APPLICATIONS

A. Tripe duty valves and three-way valves are not permitted.

B. Install shutoff-duty valves at each branch connection to supply mains and at supply and return connections to each piece of equipment.

C. Install calibrated balancing valves on the inlet of all hydronic terminal units with inlets 1-1/2-inches and smaller. This includes but is not limited to fan coils, unit heaters, radiation, radiant panels, and coils. Refer to drawing details for additional information.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Air bleeders shall be square shank 5126 loose key by Moon, Inc.

B. Install manual air vents at high points in piping, at heat-transfer coils, and as required for system air venting. Install manual air vents as indicated on the piping details. Use 3/8-inch ball valves for manual air vents on main piping and heat-transfer coils. Air vent valves shall be vertically mounted with a discharge tube curved 180 degrees.

C. Install automatic air vents in mechanical equipment rooms only.

D. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

E. Install tangential air separator in pump suction. Install blow down piping with full-port ball valve; extend full size to nearest floor drain.

F. Install bypass chemical feeders in each hydronic system, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

G. Install diaphragm expansion tanks on the floor or suspended from the structure above as indicated on the drawings. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

1. Install expansion tank isolation valve, manual air vent, and pressure gauge adjacent to tank pipe connection.

H. Install automatic control valves and sensor immersion wells in piping systems as required. Refer to Division 23 Section “Instrumentation And Control For HVAC”.

1. Install automatic control valves according to manufacturer’s recommendations, and where accessible and serviceable. Install automatic control valves in piping with union or flange connections, and between isolation valves such that the valves can be serviced without draining the piping system.

2. Install sensor immersion wells in piping where control devices are accessible and serviceable.

I. Install spherical rubber flexible connectors according to the manufactures installation instructions. Provide flexible connectors for connection to pumps, chillers, and other vibration producing equipment.
J. Flow measuring device: Install differential-pressure-type venturi's where indicated on the drawings with straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.

END OF SECTION
SECTION 232123
HYDRONIC PUMPS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
2. Separately coupled, base mounted, end-suction centrifugal pumps.
3. Automatic condensate pump units.

1.2 DEFINITIONS
A. Buna-N: Nitrile rubber.
B. EPT: Ethylene propylene terpolymer.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump’s operating point on curves.
B. Shop Drawings: For each pump.
1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.
B. Startup Report.

1.5 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Mechanical Seals: One mechanical seal for each pump.

PART 2 PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ITT Corporation; Bell & Gossett. (www.bell-gossett.com)
B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.
C. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tapping’s at inlet and outlet, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.

3. Pump Shaft: Steel, with copper-alloy shaft sleeve.

4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

5. Pump Bearings: Oil lubricated; bronze-journal or thrust type.

D. Motor: Single speed and rigidly mounted to pump casing.
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
      a. Enclosure: Totally enclosed, fan cooled.
      b. Enclosure Materials: Cast iron.
      c. Motor Bearings: Permanently lubricated ball bearings.
   3. Shaft: Grounded – for motors with variable frequency drives
      a. Provide Aegis SGR or approved equivalent for shaft grounding.
      b. Install per manufacturer instructions.

E. Refer to drawing schedules for capacities and characteristics

2.2 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Pumps Incorporated (www.armstrongpumps.com)
   2. ITT Corporation; Bell & Gossett. (www.bell-gossett.com)
   3. TACO Incorporated. (www.taco-hvac.com)

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Pump Construction:
   1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
   3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
   4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
   5. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.

D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, secured to mounting frame, with adjustable alignment.
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
      a. Enclosure: Totally enclosed, fan cooled.
      b. Enclosure Materials: Cast iron.
   3. Shaft: Grounded – for motors with variable frequency drives
      a. Provide Aegis SGR or approved equivalent for shaft grounding.
      b. Install per manufacturer instructions.

H. Refer to drawing schedules for capacities and characteristics:

2.3 AUTOMATIC CONDENSATE PUMP UNITS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Little Giant Pump Co. (www.littlegiant.com)
   4. Mepco, LLC. (www.mepcollc.com)
B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch- (1800-mm-) minimum, electrical power cord with plug.
   1. For condensate pumps located in return air plenums, pump must be plenum-rated (aluminum construction, hard-wired power connection)
C. Condensate pumps shall be equipped with alarm contacts.
D. Capacities and Characteristics:
   1. Refer to the schedule on the Drawings

2.4 PUMP SPECIALTY FITTINGS
A. Suction Diffuser:
   1. Angle pattern.
   2. 175-psig pressure rating, ductile-iron body and end cap, pump-inlet fitting.
   3. Bronze startup and bronze or stainless-steel permanent strainers.
   4. Bronze or stainless-steel straightening vanes.
   5. Drain plug.
   6. Factory-fabricated support.

2.5 ELECTRICAL CONNECTION
A. For all pumps, refer also to Electrical Coordination schedule for electrical connection requirements. Electrical connection requirements include, but are not limited to, variable speed drives, disconnects, voltage, controls/switching.

2.6 BUILDING AUTOMATION SYSTEM INTERFACE
A. Refer also to Sequence of Operation for necessary control and interface requirements.
PART 3 EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

E. Equipment Mounting: Install base-mounted pumps on cast-in-place concrete equipment base(s) using restrained spring isolators. Comply with requirements for equipment bases specified in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 23 sections.

F. Floor mounted pumps shall be installed on 1” shim to allow for grout to flow under base.

G. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support weight of in-line pumps.

H. Equipment Mounting: Install base-mounted pumps on cast-in-place concrete equipment base(s) using restrained spring isolators.

3.3 ALIGNMENT

A. Engage a factory-authorized service representative to perform laser alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill base-plate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install check valve, calibrated balancing valve, and flow measuring device on discharge side of pumps.

E. Install Y-type strainer and suction diffuser and shutoff valve on suction side of pumps.
F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

G. Install single gage with multiple-input selector valve.

H. Install check valve and gate or ball valve on each condensate pump unit discharge.

I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service and startup report.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check piping connections for tightness.

3. Clean strainers on suction piping.

4. Perform the following startup checks for each pump before starting:
   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in the correct direction.
   d. Verify fluid pH; do not operate pumps outside of the manufacturer's limitations.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.


7. Open discharge valve slowly.

8. Measure water flow, gallons per minute, and include in startup report.

9. Measure pump pressure, feet of head, and include in startup report.

10. Measure motor amp draw; include in startup report.

B. Startup reports shall indicate that items listed in this article have been completed and include required data.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION
SECTION 232300
REFRIGERANT PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes refrigerant piping used for air-conditioning applications related to Split-System Air Conditioning Units.

1.3 PERFORMANCE REQUIREMENTS
A. Line Test Pressure for Refrigerant R-410A:

1.4 SUBMITTALS
A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Hot-gas bypass valves.
   4. Filter dryers.
   5. Strainers.
   6. Pressure-regulating valves.
B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Shop Drawing Scale: 1/4 inch equals 1 foot.
   2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
C. Welding certificates.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
1.6 PRODUCT STORAGE AND HANDLING
A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 COORDINATION
A. Coordinate layout and installation of refrigerant piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
B. Coordinate pipe sleeve installations for foundation wall penetrations.
C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."
D. Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
E. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 PRODUCTS

2.1 COPPER TUBE AND FITTINGS
A. Copper Tube: ASTM B 280, Type ACR.
B. Wrought-Copper Fittings: ASME B16.22.
C. Wrought-Copper Unions: ASME B16.22.
D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
E. Brazing Filler Metals: AWS A5.8.
F. Flexible Connectors:
   2. End Connections: Socket ends.
   3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
   5. Maximum Operating Temperature: 250 degrees F.

2.2 STEEL PIPE AND FITTINGS
A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; Type, Grade, and wall thickness as selected in Part 3 piping applications articles.
B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.
C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.
E. Flanged Unions:
   1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3. Apply rust-resistant finish at factory.
   2. Gasket: Fiber asbestos free.
3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.

4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.

5. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.


7. Maximum Operating Temperature: 330 degrees F.

F. Flexible Connectors:
   2. End Connections:
      a. NPS 2 and Smaller: With threaded-end connections.
      b. NPS 2-1/2 and Larger: With flanged-end connections.
   3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
   5. Maximum Operating Temperature: 250 degrees F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
   1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
   3. Operator: Rising stem and hand wheel.
   5. End Connections: Socket, union, or flanged.
   7. Maximum Operating Temperature: 275 degrees F.

B. Packed-Angle Valves:
   1. Body and Bonnet: Forged brass or cast bronze.
   2. Packing: Molded stem, back seating, and replaceable under pressure.
   3. Operator: Rising stem.
   5. Seal Cap: Forged-brass or valox hex cap.
   6. End Connections: Socket, union, threaded, or flanged.
   8. Maximum Operating Temperature: 275 degrees F.

C. Check Valves:
   1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
   2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
   6. End Connections: Socket, union, threaded, or flanged.
   7. Maximum Opening Pressure: 0.50 psig.
   9. Maximum Operating Temperature: 275 degrees F.

D. Service Valves:
   1. Body: Forged brass with brass cap including key end to remove core.
   2. Core: Removable ball-type check valve with stainless-steel spring.
   4. End Connections: Copper spring.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
   4. End Connections: Threaded.
   5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24V ac coil.
   7. Maximum Operating Temperature: 240 degrees F.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
   4. End Connections: Threaded.
   6. Maximum Operating Temperature: 240 degrees F.

G. Thermostatic Expansion Valves: Comply with ARI 750.
   1. Body, Bonnet, and Seal Cap: Forged brass or steel.
   4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
   5. Suction Temperature: 40 degrees F.
   7. Reverse-flow option (for heat-pump applications).
   8. End Connections: Socket, flare, or threaded union.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
   1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
   5. Seat: Polytetrafluoroethylene.
   7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
   11. Maximum Operating Temperature: 240 degrees F.

I. Straight-Type Strainers:
   2. Screen: 100-mesh stainless steel.
   3. End Connections: Socket or flare.
   5. Maximum Operating Temperature: 275 degrees F.

J. Angle-Type Strainers:
   1. Body: Forged brass or cast bronze.
   2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh Monel.
4. End Connections: Socket or flare.
6. Maximum Operating Temperature: 275 degrees F.

K. Moisture/Liquid Indicators:
   2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
   3. Indicator: Color coded to show moisture content in ppm.
   5. End Connections: Socket or flare.
   7. Maximum Operating Temperature: 240 degrees F.

L. Replaceable-Core Filter Dryers: Comply with ARI 730.
   1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
   2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
   4. Designed for reverse flow (for heat-pump applications).
   5. End Connections: Socket.
   9. Maximum Operating Temperature: 240 degrees F.

M. Permanent Filter Dryers: Comply with ARI 730.
   2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
   4. Designed for reverse flow (for heat-pump applications).
   5. End Connections: Socket.
   9. Maximum Operating Temperature: 240 degrees F.

N. Receivers: Comply with ARI 495.
   1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   2. Comply with UL 207; listed and labeled by an NRTL.
   4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
   5. End Connections: Socket or threaded.
   7. Maximum Operating Temperature: 275 degrees F.

O. Liquid Accumulators: Comply with ARI 495.
   2. End Connections: Socket or threaded.

2.4 REFRIGERANTS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
PART 3 EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot-gas bypass valves.
   4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.
3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 23 Sections "Instrumentation and Controls for HVAC" and "Sequence of Operation" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 8 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

R. Seal penetrations through fire and smoke barriers according to Division 7 Section "Through-Penetration Firestop Systems."

S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

U. Seal pipe penetrations through exterior walls according to Division 7 Section "Joint Sealants" for materials and methods.
V. Identify refrigerant piping and valves according to Division 23 Section “Identification for HVAC Piping and Equipment.”

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
E. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”
B. Install roof supports according to the roof support manufacturer’s recommendations. Refer to Division 23 Section “Hangers and Supports for HVAC Piping and Equipment” for roof supports.
C. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
   2. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
D. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
   4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
E. Support multi-floor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.

d. Remake leaking joints using new materials and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
   4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION
SECTION 232500
HVAC WATER TREATMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following HVAC water-treatment systems:
   1. Bypass chemical-feed equipment and controls.
   2. Chemical treatment test equipment.
   3. HVAC water-treatment chemicals.
   4. Water filtration units for HVAC makeup water.

1.3 PERFORMANCE REQUIREMENTS
A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
C. Closed hydronic systems, including hot-water heating, chilled water, shall have the following water qualities:
   1. PH: Maintain a value within 7.0 to 9.0.
   2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
   3. Boron: Maintain a value within 100 to 200 ppm.
   4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
   5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   6. TDS: Maintain a maximum value of 10 ppm.
   9. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
      c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
      d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
      e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

1.4 SUBMITTALS
A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
   1. Bypass feeders.
   2. Chemical test equipment.
   3. Chemical material safety data sheets.
   4. Bag- or cartridge-type filters.
B. Shop Drawings: Chemical treatment equipment, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For sensors, injection pumps, water softeners, RO equipment, water filtration units, and controllers to include in emergency, operation, and maintenance manuals.

E. Other Informational Submittals:
   1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.

1.5 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for:
   1. Cooling equipment; chilled-water piping.
   2. Heating equipment, hot-water piping.

B. Services and chemicals shall be provided for a period of not less than one year from date of Substantial Completion, and shall include the following:
   1. Initial water analysis and HVAC water-treatment recommendations.
   2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
   3. Periodic field service and consultation.
   5. Laboratory technical analysis.
   6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 PRODUCTS

2.1 SERVICE VENDORS

A. Eldon Water.

B. Subject to approval by Wayne State University.

2.2 STAINLESS-STEEL PIPES AND FITTINGS

A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.

B. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig SWP and 600-psig CWP ratings.
2.3 CHEMICAL TREATMENT TEST EQUIPMENT
A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Sample Cooler:
   1. Tube: Sample.
      a. Size: NPS 1/4 tubing.
      b. Material: ASTM A 666, Type 316 stainless steel.
      d. Temperature Rating: Minimum 850 deg F.
   2. Shell: Cooling water.
      a. Material: ASTM A 666, Type 304 stainless steel.
      c. Temperature Rating: Minimum 450 deg F.

C. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
   1. Two-station rack for each closed-loop systems.

2.4 CHEMICALS
A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

2.5 FILTRATION EQUIPMENT
A. Bag or Cartridge-Type Filters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Haramscoc – HIF housing model
   2. Description: Floor-mounting housing with filter cartridges for removing particles from water.
      a. Housing: Corrosion resistant; designed to separate inlet from outlet and to direct inlet through cartridge-type water filter; with base, feet, or skirt.
         1) Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
         2) Steel Housing Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
         3) Plastic Housing Pipe Connections NPS 2-1/2 and Larger: 150-psig plastic flanges.
      b. Cartridge: Replaceable; of shape to fit housing.
   3. Capacities and Characteristics:
      a. Filter Design:
         1) Water Flow Rate: 12 gpm
         2) Filtration Efficiency: 98 percent.
         3) Particle Size: 5 microns and larger.
         4) Clean Pressure Loss: .15 psig.
5) Pressure Loss at Replacement: 4 psig.

b. Housing:
   1) Material: Type 316 Stainless Steel.
   2) Pressure Rating: 150 psig.
   3) Seal Material: EPDM.
   4) Diameter: 13 inches
   5) Height or Length: 19.5 inches
   6) Inlet and Outlet Size: 1-1/2" NPT
   7) Drain Size: 1" NPT
   8) Bag Support Basket Material: Stainless steel

c. Cartridge: Haramsco WaterBetter
   1) Number Required: 4
   2) Nominal Diameter: 2-3/4 inches
   3) Nominal Length: 9-3/4 inches
   4) Media Material: Polyester.

2.6 BYPASS WATER FILTER / CHEMICAL FEEDER

A. Description: Stainless Steel upflow water filter assembly with removable head
   1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
   2. Material: 304 Stainless Steel
   3. Holding Rods: 304 Stainless Steel
   4. Rim Gaskets: EPDM
   5. O-Rings: Buna-N
   6. Bottom Seals: EPDM
   7. Pressure Rating: 150 psig

B. Manufacturer
   1. Haramsco – HF Series

PART 3 EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 OWNER REQUIREMENTS

A. Verify if water treatment chemical will be provided by Owner or purchased through the owner.
B. Owner’s water treatment company shall verify all water treatment testing and results.

3.3 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer’s recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
B. Install interconnecting control wiring for chemical treatment controls and sensors.
C. Mount sensors and injectors in piping circuits.
D. Bypass Feeders: Install in closed hydronic systems, including hot-water heating and chilled water, and equipped with the following:
   1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   2. Install water meter in makeup water supply.
3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
5. Install a swing check on inlet after the isolation valve.

E. Water Filters: Install in closed hydronic systems, including hot-water heating and chilled water, and glycol cooling, and equipped with the following:
1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
2. Install water meter in makeup water supply.
3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
5. Install a swing check on inlet after the isolation valve.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.
C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Common Work Results for HVAC."
D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."
E. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.
F. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.
G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
B. Tests and Inspections:
1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

8. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Remove and replace malfunctioning units and retest as specified above.

D. At four-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 “Performance Requirements” Article.

E. Comply with ASTM D 3370 and with the following standards:

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 01 Section "Demonstration and Training."

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION
PART 1 – GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions
      and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in
      pressure classes from minus 2-inches to plus 10-inches wg. Metal ducts include the following:
      1. Rectangular ducts and fittings.
      2. Single-wall round longitudinal-seam ducts and formed fittings.
      4. Duct liner.
      5. Dust collector ductwork
      6. Paint booth ductwork
   B. Related Sections include the following:
      1. Refer to Division 7 Section "Joint Sealants" for fire-resistant sealants for use around duct
         penetrations and fire-smoke damper installations in fire-smoke rated floors, partitions, and
         walls.
      2. Refer to Division 8 Section "Access Doors" for wall and ceiling-mounted access doors for
         access to concealed ducts.
      3. Refer to Division 10 Sections “Louvers and Vents” for intake air, exhaust air, and relief air
         louvers connected to ducts and installed in exterior walls.
      4. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting
         access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS
   A. Exposed Duct: Ducts that are visible; except in mechanical equipment rooms.

1.4 SYSTEM DESCRIPTION
   A. Duct system design, as indicated, has been used to select size and type of air-moving and -
      distribution equipment and other air system components. Changes to layout or configuration of
      duct system must be specifically approved in writing by Architect. Accompany requests for layout
      modifications with calculations showing that proposed layout would provide original design results
      without increasing system total pressure.

1.5 SUBMITTALS
   A. Product Data: Include details of construction, materials, and dimensions of individual components,
      profiles, and finishes for the following items:
      1. Fire Stopping Materials.
      2. Duct Transverse Joints.
      3. Liners and adhesives.
      4. Sealants and gaskets.
      5. Duct Connection Systems
   B. Shop Drawings: Drawn to scale not smaller than 1/4 inch equals 1 foot. Show fabrication and
      installation details for the size and types of metal ducts in the Project.
      1. Duct fabrication, assembly, and installation details.
      2. Duct sizes and materials thickness for the various systems and duct pressure classes.
      3. Sealing class.
      4. Fittings.
5. Reinforcement and spacing.
6. Seam and joint construction.
7. Penetrations through fire-rated and other partitions.
8. Hangers and supports.
11. Plenums.

C. Coordination Drawings: Floor plans, or reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other and with the Work of other trades.
1. Duct layout plans indicating size and pressure class. Include elevations and sections, as may be necessary to demonstrate coordination.
2. Dimensions of main duct run from building grid lines.
3. Elevations of top and bottom of ducts.
4. Duct cross-over/under details.
5. Equipment installation based on equipment being used on Project.
6. Ceiling suspension assembly members.
7. Other systems installed in the same space as ducts.
8. Ceiling and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
9. Ceiling-mounted lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special details or moldings.

D. Welding certificates.
E. Field quality-control test reports.

1.6 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to:

B. NFPA Compliance:
2. NFPA 90B, “Installation of Warm Air Heating and Air Conditioning Systems.”

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS
A. Comply with SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thickness, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653 and having G90 coating designation.
1. Ducts shall have mill-phosphatized “Paint-Grip” finish for surfaces of ducts exposed to view that are scheduled for field painting.
C. Carbon-Steel Sheets: ASTM A1008/A1008M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.
D. Stainless Steel: ASTM A 480, Type 316, and having a No. 2D finish for concealed ducts and No. 4 finish for exposed ducts.

E. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish (mechanically polished) for exposed ducts.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
   1. Black steel reinforcement may be used on galvanized sheet metal ducts and on aluminum or stainless steel ducts if painted with zinc-chromate primer prior to fabrication.
   2. Use aluminum or stainless steel reinforcement on aluminum or stainless steel ducts exposed to view.

G. Tie Rods: Galvanized steel, 3/8-inch minimum diameter. Rigid conduit, minimum 3/4-inch, can be used in accordance with referenced standards.

2.3 SEALANT MATERIALS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   1. Ductmate Industries, Incorporated (PROseal & FIBERseal)

B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

C. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, use O.

D. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 FIRESTOPPING
A. Refer to Division 7 for fire-resistant sealants and fire-stopping materials for use around duct penetrations and fire damper installations in fire rated floors, partitions, and walls.

2.5 HANGERS AND SUPPORTS
A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Use powder-actuated concrete fasteners for standard-weight aggregate concrete’s or for slabs more than 4 inches thick.
   2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concrete’s or for slabs less than 4 inches thick.
   3. Exception: Do not use powder-actuated concrete fasteners in post-tensioned concrete slabs where the cable locations are not known. Fasteners shall not exceed 3/4-inch embedment.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
   1. Hanger’s installed in Corrosive Atmospheres: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer prior to installation.
   2. Strap and Rod Sizes: Comply with SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
   3. Use stainless steel straps or rods for stainless steel ducts exposed to view. Steel materials may be used for concealed ducts if painted with zinc-chromate primer prior to installation.
   4. Use aluminum straps or rods for aluminum steel ducts exposed to view. Steel materials may be used for concealed ducts if painted with zinc-chromate primer prior to installation.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36.
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates. Black steel shapes and plates may be used if painted with zinc-chromate primer prior to installation.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials if ducts are exposed to view. Steel materials may be used for concealed ducts if painted with zinc-chromate primer prior to installation.
3. Supports for Aluminum Ducts: Aluminum supports materials if ducts are exposed to view. Steel materials may be used for concealed ducts if contact surfaces are painted with zinc-chromate primer prior to installation.

2.6 DUCT FABRICATION-GENERAL
A. Comply with SMACNA’s “HVAC Duct Construction Standards--Metal and Flexible,” and with the requirements of this Section.
B. Comply with SMACNA’s “Rectangular Industrial Duct Construction Standards” for acceptable materials, material thickness, and duct construction methods outside the scope of SMACNA’s “HVAC Duct Construction Standards--Metal and Flexible.”
C. Duct Pressure Classification: Construct duct systems for the following pressure classifications:
   1. Supply Air Ducts:
      a. Supply air ducts on variable-volume air systems between fan outlet and air terminal units: 4-inches water gage positive pressure.
      b. Supply air ducts on all constant volume air systems, and all supply ducts downstream of air terminal units on variable volume air systems: 2 inches water gage, positive pressure.
   2. Return and Relief Air Ducts: 2 inches water gage, negative pressure.
   3. Exhaust Air Ducts: 2 inches water gage, negative pressure.
   4. Laboratory Fume Hood Exhaust Air Ducts: 3 inches water gage, negative pressure.
   5. Organ blower ducts: 20 inches water gage positive pressure
   6. Other Ducts: 2 inches water gage positive or negative pressure.
D. Duct Sealing Classification: Provide SMACNA “Seal Class A” for all duct pressure classifications.
   1. Seal all transverse joints, longitudinal seams, and duct penetrations.
   2. Seal to achieve no visible or audible leaks.
E. Materials: All ducts shall be galvanized steel, except as follows:
   1. Ducts at Duct-Mounted Humidifiers.
   2. Ducts noted otherwise on the Drawings.

2.7 RECTANGULAR DUCT FABRICATION
A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA’s “HVAC Duct Construction Standards--Metal and Flexible.” Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals, and with the requirements of this Section.
   1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
   2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's “HVAC Duct Construction Standards--Metal and Flexible.”
   3. Calculations: When duct construction is outside the scope of SMACNA’s “HVAC Duct Construction Standards--Metal and Flexible,” provide calculations to demonstrate compliance with Duct Pressure Classification.
   4. Manufacturers:
      a. Ductmate Industries, Inc.
      b. Elgen Manufacturing
      c. Nexus Inc.
      d. Ward Industries, Inc.
      e. SET Duct
      f. Lapine Metal Products
      g. Universal Spiral Air
B. Transverse Joints:
   1. Prefabricated Slide-On Joints and Components:
      a. Manufacturers:
1) Ductmate Industries, Inc.
2) Elgen Manufacturing
3) Nexus Inc.
4) Ward Industries, Inc.

b. Apply joints using manufacturer’s “Duct Construction Standards” for material thickness, reinforcement size and spacing, and joint reinforcement. “Duct Construction Standards” must be based on the referenced SMACNA Standards. “Duct Construction Standards” shall be submitted as shop drawings, and must be available upon request at the Project Site.

c. Slide-on joints must include the use of corners, bolts, cleats, and gaskets.
d. Gaskets must be suitable for application at temperatures experienced at the Project Site.

2. Formed-On Flanges:
   a. Manufacturers:
      1) Ductmate Industries Incorporated
      2) Elgen Manufacturing
      3) T.D.C.
      4) T.D.F.
   b. Construct according to SMACNA's “HVAC Duct Construction Standards--Metal and Flexible,” Table 1-12. Formed-on flanges shall be constructed as T-25A (T.D.C.) and T-25B (T.D.F.) joints.
   c. Formed-on flanges must include the use of corners, bolts, cleats, and gaskets.
   d. Gaskets must be suitable for application at temperatures experienced at the Project Site.
   e. Duct Size: Maximum 42-inches wide and up to 4-inches wg pressure class.
   f. Duct Size: Maximum 60-inches wide and up to 4-inches wg pressure class.

3. Slips and Drives (Traditional):
   a. Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Tables 1-11 or 1-12.

C. Longitudinal Seams: Pittsburgh-lock sealed with non-curing polymer sealant.

D. Internal Tie Rod Reinforcements: Do not use a transverse or intermediate reinforcement that requires the use of internal tie rods on ducts less than 96-inches wide.

E. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of non-braced panel area unless ducts are lined.

F. All-Welded Construction: Provide continuously welded longitudinal and transverse duct joints and seams on ducts as indicated.

G. Ducts at Duct-Mounted Humidifiers: Fabricate ducts 12-inches upstream and 42-inches downstream of humidifiers with 18-gage stainless steel sheets. Provide all-welded construction. Ducts shall be liquid-tight over their entire length. Provide threaded waste fittings with caps at low points. Refer to Drawings and Details for additional requirements. Ducts shall be liquid-tight over their entire length.

H. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division 23 section "Ductwork Accessories" for accessory requirements.

I. Fabricate ductwork so as to be free from vibration, rattling, or "oil-canning" under all operating conditions.

J. Unless otherwise indicated, the net free area of the duct dimensions given on the Drawings shall be maintained. The duct dimensions shall be increased as necessary to compensate for liner thickness.

2.8 RECTANGULAR DUCT FITTINGS

A. General: Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standards-Metal and Flexible," Figures 2-1 through 2-10.

B. Elbows and Divided Flow Fittings: Fabricate fittings with a centerline radius equal to 1.5 times the associated duct widths up to 28 inches wide, and 1.0 times the duct width for ducts 30 inches wide and wider. Figure 2-2; Type RE 1 radius elbow.
1. Where elbows with a shorter radius are necessary, fabricate elbows with a 4-inch throat radius, full radius heel, and with short radius vanes. Figure 2-2, Type RE-3. Fabricate short radius vanes according to Appendix pages A.41, A.42 and A.43.

2. Do not use square elbows, except where indicated on the Drawings. Where used, fabricate square elbow with single-wall turning vanes.

C. Transitions and Offsets: Limit concentric transitions to 45 degrees for diverging, and 60 degrees for converging; limit single-sided transitions to 22.5 degrees for diverging and 30 degrees for converging. Limit angled offsets to a maximum of 30 degrees.

D. Branch Connections: Fabricate branch connections according to Figure 2-6 using clinch lock joints and 45-degree entry.

2.9 ROUND AND FLAT-OVAL DUCT FABRICATION

A. Fabricate ducts according to SMACNA’s "HVAC Duct Construction Standards-Metal and Flexible," Tables 3-2 and 3-3.

B. Duct Pressure Classification and Duct Sealing Classification: As indicated in previous Article "Duct Fabrication, General."

C. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

D. Round Longitudinal Lock-Seam Ducts 14-inches and smaller:

1. Manufacturers:
   a. Ductmate Industries, Incorporated
   b. SET Duct
   c. Lapine Metal Products
   d. Universal Spiral Air

2. Fabricate round ducts with longitudinal grooved “Green Seam” snap lock pipe. Figure 3-1, Type RL-5.

3. Longitudinal snaplock seams may be used for round duct diameters 14-inches and smaller for 2-Inch Duct Pressure Classifications. Figure 3-1, Type RL-6, RL-7. RL-78.

E. Round and Flat Oval, Longitudinal and Spiral-Lock-Seam Ducts 16-inches and larger:

1. Manufacturers:
   b. Semco Incorporated.
   c. Sheetmetal Connectors Incorporated.
   d. SET Duct
   e. Lapine Metal Products
   f. Universal Spiral Air

2. Fabricate round ducts with spiral lockseam. Figure 3-1, Type RL-1.

3. Fabricate round ducts with longitudinal grooved seam. Figure 3-1, Type RL-5.

4. Provide continuous butt-welded longitudinal seams on ducts larger than 72-inches, and where otherwise indicated. Figure 3-1, Type RL-4.

F. Transverse Duct Joints.

1. Manufacturers:
   a. Ductmate Industries Incorporated.
   b. Elgen Manufacturing
   c. Semco Incorporated.

2. Duct up to 20-Inches Diameter: Interior, center-beaded slip coupling. Figure 3-2, Type TR-1.
   a. Beaded crimp joints may be used for round duct diameters 14-inches and smaller for 2-Inch Duct Pressure Classifications. Figure 3-2, Type TR-5.
   b. Prefabricated self sealing gasketed coupler: Ductmate “Bullet Band”.

3. Ducts 21 to 72-Inches Diameter: Prefabricated three-piece, gasketed, flanged joint consisting of two inner ring flanges with sealant and one external closure band with gasket. Ductmate “Spiralmate” or equivalent.
   a. Prefabricated flanged joint consisting of two external flanges with sealant and gasket may be used for concealed ducts. Ductmate “Econoflange,” Semco “Accuflange,” or equivalent.
b. Prefabricated self sealing gasketed coupler: Ductmate “Bullet Band”.

4. Ducts larger than 72-Inches Diameter: Companion angle flanged joints with gasket, sealed before and after fastening. Figure 3-2, Type RT-2.
   a. Prefabricated self sealing gasketed coupler: Ductmate “Bullet Band”.

5. Joints shall be made with mechanical fasteners (sheet metal screws, blind rivets, welds, bolts). Use sealer before and after fastening.

6. Traverse Duct Joints on exposed ducts.
   a. Prefabricated self sealing gasketed coupler: Ductmate “Bullet Band”.

G. Unless otherwise indicated, the net free area of the duct dimensions given on the Drawings shall be maintained. The duct dimensions shall be increased as necessary to compensate for liner thickness

2.10 ROUND AND FLAT OVAL DUCT FITTING FABRICATION

A. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Elgan Manufacturing
   d. Semco Incorporated.
   e. Sheetmetal Connectors Incorporated.
   f. SET Duct
   g. Lapine Metal Products
   h. Universal Spiral Air

B. General: Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standards-Metal and Flexible," Figures 3-3 through 3-5.
   1. Duct fittings shall be fabricated from metal thickness not less than required for longitudinal-seam straight duct in Tables 3-2 and 3-3.

C. Round Duct Takeoffs from Rectangular Ducts: Fabricate takeoffs with clinch-lock or spin-in conical connectors with volume dampers.
   1. Straight connectors may be used for 2-inch Duct Pressure Classification.

D. Elbows: Fabricate with welded seam, die-formed or segmented construction with bend radius 1.5 times the elbow diameter.
   1. Die-Formed Elbows (8-Inches and smaller): Fabricate elbows with two-piece, die-formed construction.
   2. Segmented Elbows (Larger than 8-Inches): Fabricate elbows with multiple segments or gores with number of pieces as follows:
      a. 90 degrees - 5 pieces.
      b. 60 degrees - 4 pieces.
      c. 45 degrees - 3 pieces.
      d. 30 degrees - 2 pieces.
   3. 90 degrees, Two-piece Mitered Elbows: Use only where space restrictions do not permit the use of radius elbows. Fabricate elbows with single thickness turning vanes.
   4. Adjustable Mitered Elbow (14-Inches and Smaller): Adjustable seam, mitered elbows (4-piece 90 degree, 3-piece 45 degree) with bend radius 0.6 times the elbow diameter may be used for 2-inch Duct Pressure Classifications. Joints shall be sealed after installation.

E. Laterals, Tees and Wyes: Fabricate with welded seam construction with conical branch taps with no excess material projecting from body into branch tap entrance.
   1. Straight branch taps may be used for 2-inch Duct Pressure Classification.
   2. Fittings with riveted or bonded joints may be used for duct diameters 16-inches and smaller for 2-inch Duct Pressure Classification. Joints shall be sealed after installation.

F. Diverging-Flow Fittings: Fabricate with welded seam with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.
2.11 DUCT LINER


1. Manufacturers:
   a. CertainTeed Corp.; Insulation Group.
   c. Knauf Fiber Glass GmbH.
   d. Owens Corning.

2. Materials: ASTM C 1071; surfaces exposed to air stream shall be coated to prevent erosion of glass fibers.

   a. Thickness: 1 inch, unless noted otherwise.
   b. Thermal Conductivity (k-Value): 0.24 at 75 degrees F mean temperature.
   c. Minimum Density: 3.0 pcf
   d. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
   e. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   f. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
      1) Tensile Strength: Indefinitely sustains a 50-lb-tensile, dead load test perpendicular to duct wall.
      2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into air stream.
      3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.
   g. Acoustic Performance: Sound absorption coefficients at octave band center frequencies.
      (Hz)
      1) 125Hz: 0.05; 250Hz: 0.30; 500Hz: 0.60; 1000Hz: 0.87; 2000Hz: 0.98; 4000Hz: 1.05; NRC: 0.70

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B. http://www.specagent.com/lookUp/?ulid=3429&mf=04&src=wd

   1. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
   2. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

2.12 APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Application of Liner:

   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps and coat joint with adhesive.
   4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
   5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
   6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
   7. Secure transversely oriented liner edges facing the air stream with metal nosing that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
      a. Fan discharges.
b. Intervals of lined duct preceding unlined duct.
c. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm or where indicated.

B. Terminate inner ducts with build-outs attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build-outs (metal hat sections) or other build-out means are optional; when used; secure build-outs to duct walls with bolts, screws, rivets, or welds.

2.13 DUST COLLECTOR DUCTWORK

A. Provide Donaldson Torit Easy Duct on all ductwork upstream of the dust collector. Use clamped connections with gasket.

B. Fabricate all ductwork downstream of the dust collector with minimum 18 gauge G90 galvanized sheetmetal. Ductwork shall be rated for +14” of static pressure.

C. Provide a cleanout access panel on the inlet and discharge ductwork every 15 feet and every change in direction. Cleanouts are not required on vertical ductwork.

2.14 SPRAY BOOTH DUCTWORK

A. Fabricate all spray booth ductwork upstream of fan from minimum 18 gauge G90 galvanized sheet metal. Fabricate all spray booth ductwork downstream of exhaust fan from minimum 18 gauge 304 stainless steel.

PART 3 - EXECUTION

3.0 DUCT INSTALLATION

A. Install ducts according to SMACNA’s “HVAC Duct Construction Standards—Metal and Flexible,” and the requirements of this Section.

B. Install ducts according to SMACNA’s “Rectangular Industrial Duct Construction Standards” when duct construction is outside the scope of SMACNA’s "HVAC Duct Construction Standards-Metal and Flexible."

C. Construct and install each duct system according to the Duct Pressure Classification and Duct Sealing Classification indicated in previous Article “Duct Fabrication, General.”

D. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.

E. Install fabricated fittings for changes in directions, size, and shape and for connections.

F. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

G. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

H. Provide offset fittings where necessary to avoid structural interference’s and in coordination with existing conditions and the Work of other trades.

I. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Provide a minimum clearance of 1 inch, plus an allowance for insulation thickness to other elements.

J. Install ducts as high as possible, unless otherwise indicated. Where overhead structure permits, route ducts between structural elements.

K. Conceal ducts from view in finished spaces by locating within mechanical shafts, within hollow construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions unless specifically indicated.
L. Where exposed to view; install ducts as high as possible, unless otherwise indicated. Protect exposed duct from physical damage. Repair scratches, dents, cuts, and other physical imperfections. Remove stickers and markers. Prepare for field painting. Grind and polish exposed welds so no roughness shows and contours of welded surfaces match adjacent contours.

M. Install insulated ducts with 1-inch clearance outside of insulation.

N. Coordinate the duct layout with suspended ceiling, fire and smoke-control dampers, piping, lighting layouts and conduits, and the Work of other trades.

O. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.

P. One hour rated fire barrier penetrations: (Where the building code allows fire barrier penetrations without fire dampers) Provide angles on both sides of the wall penetrations conforming to the requirements of wall system approval.

Q. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and fire stopping sealant.
   1. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories."
   2. Fire stopping materials and installation methods are specified in Division 7 Section "Fire stopping."

R. Protect duct interiors from elements and foreign materials until building is enclosed. Refer to SMACNA’s “Duct Cleanliness for New Construction.”

S. Paint interiors of metal ducts that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish paint over a compatible galvanized steel primer. Paint materials and application requirements are specified in Division 9 Sections.

3.1 DUCT LINER APPLICATIONS

A. Apply duct liner in the following duct sections:
   1. Supply air ductwork: Provide 1-inch thick elastomeric duct liner for any supply air ductwork noted on the drawings (both round and rectangular trunk ducts).
   2. Return air ductwork: Provide 1-inch thick elastomeric duct liner for any supply air ductwork noted on the drawings (both round and rectangular trunk ducts).
   3. Exhaust air ductwork: None.
   4. Transfer air ducts: Provide 1-inch thick fiberglass duct liner for all transfer air ducts.
   5. Provide 1-inch thick elastomeric duct liner for any duct noted on the Drawings to be lined, unless the Drawings indicate a thicker liner.

3.2 WALL LOUVERS

A. Provide watertight air plenum with soldered drain pan at each louver. Connect air plenum directly to louver frame. The air plenum drain pan shall be arranged to drain through the louver to the building exterior.

B. Provide 2 inch thick insulated double-wall blank-off panels at each unused wall louver. Blank-off panels shall be attached to the louver frame with a gasketed, watertight connection.

3.3 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

B. Duct Sealing Classification: Provide SMACNA "Seal Class A" for all duct pressure classifications.
   1. Seal all transverse joints, longitudinal joints, and duct penetrations.
   2. Seal to achieve no visible or audible leaks.

C. Seal externally insulated ducts before insulation is applied.

D. Seal exposed joints internally during installation. Do not use external sealant on exposed ducts.
3.4 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. Install concrete inserts before placing concrete.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs greater than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured.
   3. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section “Duct Accessories.”

B. For branch connections comply with SMACNA’s “HVAC Duct Construction Standards-Metal and Flexible,” Figures 2-5 and 2-6.

C. For inlet and outlet connections comply with SMACNA’s “HVAC Duct Construction Standards-Metal and Flexible,” Figures 2-14 and 2-15.

D. For equipment connections comply with SMACNA’s "HVAC Duct Construction Standards -Metal and Flexible," Figures 2-17.

3.6 PAINTING

A. Exposed galvanized ducts: Paint materials and methods are specified in Division 9 Sections.

3.7 FIELD QUALITY CONTROL

A. Perform field tests and inspections according to SMACNA’s “HVAC Air Duct Leakage Test Manual” and prepare test reports.

B. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

C. Conduct tests at static pressures equal to Duct Pressure Classification designated static pressures.

D. Conduct tests in the presence of the Architect, or authorized representative. Give 7 day’s advanced notice for testing. Prepare test reports.

E. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

F. Leakage Tests:
   1. Leak test each section of duct with a Duct Pressure Classification greater than 2-inches wg.
   2. Leak test each section of duct within a concealed shaft.
   3. Leak test each section of laboratory fume hood exhaust duct.
   4. Leak test a representative section of duct with a Duct Pressure Classification of 2-inches or less. Test a section with a positive pressure classification, and a section with a negative pressure classification.
      a. Following a successful test, all other ductwork in the Duct Pressure Classification shall be visually inspected to assure duct construction methods are like the tested sections.
      b. Additional sections shall be tested as requested by the Architect.
G. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for ducts with a Duct Pressure Classification greater than 2-inches, and for Leakage Class 6 for ducts with duct pressure classification 2-inches or less.
   a. For a duct section with 4-inch Duct Pressure Classification or greater and Duct Leakage Class 3, leakage shall not exceed 7.5 CFM per 100 sq. ft. of duct surface area.
   b. For a duct section with a 2-inch Duct Pressure Classification and Duct Leakage Class 6, leakage shall not exceed 9.5 CFM per 100-sq. ft. of duct surface area.
   c. For positive pressure exhaust ducts, leakage shall be zero at 4.0 inches wg.

3.8 TEMPORARY USE OF AIR HANDLING SYSTEMS

A. Until the permanent air handling systems are used, duct openings shall have closures to preclude the entry of construction dirt and debris into the duct system and equipment.

B. If the permanent air handling systems are used for temporary heating or ventilating prior to completion of finishing operations, the supply air systems shall be operated with 100 percent outside air (no recirculation air) with pre-filters and final filters in place and maintained.
   1. Operation of air handling systems may not be possible during extreme outside air conditions.
   2. The return air and exhaust air systems shall not be used. The duct openings on these systems shall have permanent closures.

C. When the building is substantially complete, the permanent air handling systems may be utilized with return air with air filters in place. Extra-ordinary measures shall be taken to prevent dirt and/or moisture from entering the duct systems.
   1. Filters: Maintain clean filters in place. Install new permanent filters prior to Owner occupancy of the Project.
   2. Equipment: Maintain fans and equipment until Owner occupancy of the Project.

D. Air handling system ducts shall be vacuum cleaned, and equipment surfaces washed as may be necessary to restore the systems to new condition prior to final acceptance by the Owner.

3.9 CLEANING NEW SYSTEMS

A. General:
   1. All duct stored on site prior to installation, and all open ends of installed ducts must be covered with adhesive end caps on open ends to prevent intrusion of construction dust and/or debris.
   2. If, upon visual review of the materials, at the discretion of the Engineer, Commissioning Authority, Architect, or Owner, it is determined that the duct systems have become dirty during the installation and construction process, cleaning new duct systems will be required.

B. Cleaning of new duct systems
   1. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
   2. Use service openings, as required, for physical and mechanical entry and for inspection.
      a. Create other openings to comply with duct standards.
      b. Disconnect flexible ducts as needed for cleaning and inspection.
      c. Remove and reinstall ceiling sections to gain access during the cleaning process.
   3. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.
   4. Clean the following metal duct systems by removing surface contaminants and deposits:
      a. Air outlets and inlets (registers, grilles, and diffusers).
      b. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
      c. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
      d. Coils and related components.
      e. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
f. Supply-air ducts, dampers, actuators, and turning vanes.

5. Mechanical Cleaning Methodology:
   a. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   b. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   c. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
   d. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.
   e. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Cleanliness Verification:
   a. Visually inspect metal ducts for contaminants.
   b. Where contaminants are discovered, re-clean and re-inspect ducts.

END OF SECTION
SECTION 233119
HVAC CASINGS AND ACOUSTIC HOUSINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Factory-fabricated, field-assembled, double-wall casings for HVAC equipment.

1.3 PERFORMANCE REQUIREMENTS
A. Static-Pressure Classes:
   1. Upstream from Fan(s): -4-inch wg.
   2. Downstream from Fan(s): 4-inch wg.
B. Acoustical Performance:
   1. NRC: 1.09 according to ASTM C 423.
   2. STC: 40 according to ASTM E 90.
   A. Prefabricated Plenum Panels: Submit test data from an independent accredited laboratory indicating sound transmission loss performance of panel system in accordance with ASTM-E90 and sound absorption performance of panels, vision ports and access doors in accordance with ASTM-C423. Submittal shall include assembly drawings and details of joints and fittings to be used in the installation.
C. Structural Performance:
   1. Casings shall be fabricated to withstand 133 percent of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed 1/8 inch per foot of width.
      a. Fabricate outdoor casings to withstand wind load of 15 lbf/sq. ft. and snow load of 30 lbf/sq. ft.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of the following products:
   1. Factory-fabricated casings.
   2. Liners and adhesives.
   3. Sealants and gaskets.
B. Shop Drawings: For HVAC casings. Include plans, elevations, sections, components, and attachments to other work.
   1. Detail HVAC casing assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Sheet metal thickness(es).
   3. Reinforcement and spacing.
   4. Seam and joint construction.
   5. Access doors including frames, hinges, and latches.
   6. Filter, coil, humidifier, and other apparatus being installed in and mounted on casing.
   7. Locations for access to internal components.
8. Hangers and supports including methods for building attachment, vibration isolation, and casing attachment.
9. Interior lighting, including switches.

1.5 INFORMATIONAL SUBMITTALS
A. Product Certificates: For acoustically critical casings, from manufacturer.
   1. Show sound-absorption coefficients in each octave band lower than those scheduled when tested according to ASTM C 423.
   2. Show airborne sound transmission losses lower than those scheduled when tested according to ASTM E 90.
B. Field quality-control reports.

1.6 QUALITY ASSURANCE
B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

1.7 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete.
B. Coordinate sizes and locations of steel supports. Supports are specified in Section 055000 "Metal Fabrications."
C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 NOISE CONTROL FOR MECHANICAL SYSTEMS
A. Some systems and equipment requirements may also be included in specification section 230548 "Noise Control for Mechanical Systems." Refer to both specification sections for acoustic requirements. Where specifications differ, the more stringent acoustic requirement applies.

2.2 GENERAL CASING AND ACOUSTICAL HOUSING FABRICATION REQUIREMENTS
A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 9, "Equipment and Casings," for acceptable materials, material thicknesses, and casing construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
   1. Fabricate casings with more than 3-inch wg negative static pressure according to SMACNA's "Rectangular Industrial Duct Construction Standards."
   2. Casings with more than 2-inch wg positive static pressure may be fabricated according to SMACNA's "Rectangular Industrial Duct Construction Standards."
B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Exterior Surface Galvanized Coating Designation: G90.
   2. Interior Surface Galvanized Coating Designation:
      a. Sections Not Exposed to Moisture: G90.
b. Sections Housing and Downstream from Cooling Coil and Humidifiers: G90.

C. Stainless Steel: ASTM A 480/A 480M, Type 304, and having a No. 2D finish.

D. Factory- or Shop-Applied Antimicrobial Coating:
1. Apply to the interior sheet metal surfaces of casing in contact with the airstream. Apply untreated clear coating to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H minimum when tested according to ASTM D 3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to UL 723; certified by an NRTL.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Sealing Requirement: SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class A. Seal all seams, joints, connections, and abutments to building.

G. Penetrations: Seal all penetrations airtight. Cover with escutcheons and gaskets, or fill with suitable compound so there is no exposed insulation. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping." Provide shaft seals where fan shafts penetrate casing.

H. Access Doors: Fabricate access doors according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 9-15, "Casing Access Doors - 2-inch wg ," and Figure 9-16, "Casing Access Doors - 3-10-inch wg "; and according to pressure class of the plenum or casing section in which access doors are to be installed.
1. Size: minimum 24 by 30 inches.
3. Hinges: Piano or butt hinges and latches, number and size according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
4. Latches: Minimum of two wedge-lever-type latches, operable from inside and outside.
5. Neoprene gaskets around entire perimeters of door frames.
6. Doors shall open against air pressure.

I. Condensate Drain Pans: Formed sections of Type 304 stainless steel sheet complying with requirements in ASHRAE 62.1. Pans shall extend a minimum of 12 inches past coil.
1. Double-wall construction shall have space between walls filled with foam insulation and sealed moisture tight.
2. Intermediate drain pan or drain trough shall collect condensate from top coil for units with stacked coils or stacked eliminators.
3. Insulation: Polystyrene or polyurethane.
4. Slopes shall be in a minimum of two planes to collect condensate from cooling coils (including coil piping connections and return bends), eliminators, and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
5. Each drain pan connection shall have a trap. Drain traps with depth and height differential between inlet and outlet equal or greater to the design static pressure plus 2-inch wg Include slab height in trap calculation.

J. Acoustical Criteria
1. Sound Transmission Loss: The octave band sound transmission loss of prefabricated plenum panels shall meet or exceed the following values measured in an accredited acoustical laboratory in dB:
   a. Frequency 63 125 250 500 1000 2000 4000 8000
Sound Absorption: The octave band sound absorption coefficients of prefabricated plenum panels shall meet or exceed the following values as measured in an accredited acoustical laboratory in accordance with ASTM-C423:

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<tr>
<th>Frequency</th>
<th>Absorption</th>
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<tr>
<td>125</td>
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</table>

2.3 SHOP-FABRICATED CASINGS AND ACOUSTICAL HOUSINGS

A. Double-Wall Casing Inner Panel: Perforated, galvanized sheet steel having 3/32-inch diameter perforations, with overall open area of 23 percent. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.

B. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Maximum Thermal Conductivity: 0.27 Btu x in. /h x sq. ft. x deg F at 75 deg F mean temperature.
   2. Coat insulation with antimicrobial coating.
   3. Cover insulation with polyester film complying with UL 181, Class 1.

C. Fabricate casings with standing seams and angle-iron reinforcements unless otherwise indicated.

D. Fabricate close-off sheets from casing to dampers, filter frames, and coils and between stacked coils. Use galvanized sheet steel of same thickness as casing and with a galvanized coating designation of G90.

E. Bolt close-off sheets to frame flanges and housings. Support coils on stands fabricated from galvanized-steel angles or channels.

F. Reinforce casings with galvanized-steel angles.

G. Acoustical Criteria
   1. Sound Transmission Loss: The octave band sound transmission loss of prefabricated plenum panels shall meet or exceed the following values measured in an accredited acoustical laboratory in dB:
      | Frequency | TL |
      |-----------|----|
      | 63        | 26 |
      | 125       | 23 |
      | 250       | 30 |
      | 500       | 42 |
      | 1000      | 51 |
      | 2000      | 59 |
      | 4000      | 58 |
      | 8000      | 58 |

2.4 MANUFACTURED CASINGS AND ACOUSTICAL HOUSINGS

A. Description: Double-wall, insulated, pressurized equipment casing.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Buffalo Air Handling. (www.customairproducts.com)
   3. SEMCO Incorporated. (www.semcohvac.com)

C. Double-Wall Panel Fabrication: Solid, galvanized sheet steel exterior wall and perforated, galvanized sheet steel interior wall; with space between wall filled with insulation.
   1. Wall Thickness: 2 inches unless noted otherwise.
   2. Fabricate with a minimum number of joints.
3. Weld exterior and interior walls to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.

4. Sheet metal thickness shall comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" for static-pressure class indicated for casing.

5. Sheet Metal Thicknesses:
   a. Exterior Wall Thickness: 0.040 inch minimum.
   b. Interior Wall Thickness: 0.034 inch minimum.


7. Fill each panel assembly with insulating material that is noncombustible, inert, mildew resistant and vermin proof and that complies with NFPA 90A.

8. Fabricate panels with continuous tongue-and-groove or self-locking joints effective inside and outside each panel.

D. Trim Items: Fabricate from a minimum of 0.052-inch galvanized sheet steel, furnished in standard lengths for field cutting.

E. Acoustical Criteria

1. Sound Transmission Loss: The octave band sound transmission loss of prefabricated plenum panels shall meet or exceed the following values measured in an accredited acoustical laboratory in dB:
   a. Frequency 63 125 250 500 1000 2000 4000 8000
   b. TL 26 23 30 42 51 59 58 56

2. Sound Absorption: The octave band sound absorption coefficients of prefabricated plenum panels shall meet or exceed the following values as measured in an accredited acoustical laboratory in accordance with ASTM-C423:
   a. Frequency 125 250 500 1000 2000 4000 8000
   b. Absorption 0.89 1.2 1.16 1.09 1.01 1.03 0.93 0.95

2.5 CASING AND ACOUSTICAL HOUSING LINER

A. Fibrous-Glass Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CertainTeed Corp.; Insulation Group. (www.certainteed.com)
   b. Johns Manville. (www.jm.com)
   c. Knauf Insulation. (www.knaufinsulation.us)
   d. Owens Corning. (www.owenscorning.com)

2. Maximum Thermal Conductivity:
   a. Type II, Rigid: 0.23 Btu x in. /h x sq. ft. x deg F at 75 deg F mean temperature.

3. Antimicrobial Erosion-Resistant Coating: Apply to surface of the liner that will form the interior surface of casing to act as a moisture repellent and an erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, stainless steel, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop or Factory Application of Casing Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of casing liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of casing liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of casings or cut and fit to ensure butted-edge overlapping.
5. Apply adhesive coating on longitudinal seams in casings with air velocity of 2500 fpm.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or “Z” profiles or are integrally formed from casing wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined casing preceding unlined duct.
   c. Upstream edges of transverse joints in casings where air velocities are higher than 2500 fpm or where indicated.
8. Secure insulation between perforated sheet metal inner wall of same thickness as specified for outer wall. Use mechanical fasteners that maintain inner wall at uniform distance from outer wall without compressing insulation.

2.6 SEALANT MATERIALS
A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. For indoor applications, sealant shall have a VOC content of 75 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
9. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
10. Service: Indoor or outdoor.
11. Substrate: Compatible with galvanized sheet steel or stainless steel.

C. Flanged Joint Sealant: Comply with ASTM C 920.
2. Type: S.
3. Grade: NS.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine concrete bases, roof curbs, and steel supports for compliance with requirements for conditions affecting installation and performance of HVAC casings.

B. Examine casing insulation materials and liners before installation. Reject casings that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install casings according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Equipment Mounting:
   1. Install HVAC casings on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Comply with requirements for vibration isolation devices specified in Section 230548 "Noise and Vibration Controls for HVAC."

C. Apply sealant to joints, connections, and mountings.

D. Field-cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Support casings on floor or foundation system. Secure and seal to base.

F. Support components rigidly with ties, braces, brackets, and anchors of types that will maintain housing shape and prevent buckling.

G. Align casings accurately at connections, with 1/8-inch misalignment tolerance and with smooth interior surfaces.

H. Locate access doors to acoustic housings in accessible locations.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Perform field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual."
   2. Test the following systems:
      a. Systems required by ASHRAE/IESNA 90.1.
      b. Supply Air: 50 percent of total installed duct area with a pressure class of 4-inch wg or higher:
         1) If any of the tests fail with excess leakage, 100% testing coverage will be required.
      c. Return and Exhaust Air: 50 percent of total installed duct area with a pressure class of 3-inch negative wg or higher:
         1) If any of the tests fail with excess leakage, 100% testing coverage will be required.
   3. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
4. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.

5. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

B. HVAC casings will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 CLEANING

A. Comply with requirements for cleaning in Section 233113 "Metal Ducts."

END OF SECTION
SECTION 233300
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   2. Control dampers.
   3. Fire dampers.
   4. Smoke dampers.
   5. Combination fire and smoke dampers.
   6. Duct silencers.
   7. Turning vanes.
   8. Remote damper operators.
   9. Duct-mounted access doors.
  10. Flexible connectors.
  11. Flexible ducts.
  12. Duct accessory hardware.
  13. Flange connectors.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings. Provide test data certified by an independent testing laboratory.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

C. Wiring Diagrams: For power, signal, and control wiring.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

E. Source quality-control reports.

F. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

B. Comply with AMCA 500-D testing for damper rating.
PART 2 PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and 4 finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT DAMPERS

A. Manufacturers:
   1. Air Balance, Incorporated.
   2. American Warming and Ventilating.
   3. CESCO Products.
   4. Duro Dyne Corporation
   5. Greenheck.
   6. Pottorff; Division of PVI Industries Incorporated
   7. Prefco Products Incorporated.
   8. Ruskin Company. (Ruskin model BD6/CBD6)
   9. Standard Metal Products

B. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

C. Frame: 0.063-inch-thick extruded aluminum, with welded corners.

D. Blades: 0.050-inch-thick aluminum sheet.

E. Blade Seals: Vinyl.

F. Blade Axles: Nonferrous.

G. Tie Bars and Brackets: Aluminum.

H. Return Spring: Adjustable tension.

2.3 MANUAL VOLUME DAMPERS

A. Manufacturers:
   1. Air Balance, Incorporated
   2. American Warming and Ventilating.
3. Flexmaster U.S.A., Incorporated
5. METALAIRE, Incorporated
6. Nailor Industries Incorporated
7. Pottorff; Division of PVI Industries Incorporated
8. Ruskin Company.
9. Standard Metal Products
10. Vent Products Company, Incorporated
11. Young Regulator Company

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat or Angle-shaped, galvanized or stainless sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch-thick galvanized or stainless sheet steel.
3. Aluminum Frames: Hat or Angle-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
7. Bearings: Oil-impregnated bronze, molded synthetic or Stainless steel sleeve thrust or ball.
10. Tie Bars and Brackets: Galvanized steel or Aluminum.
11. Jackshaft: 1-inch-diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   a. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

D. Round manual volume dampers.

1. Fabrication:
   a. Frame: None.
   b. Blade:
      1) Style: Round, single-piece.
      2) Material: Minimum 20 gage galvanized steel.
   c. Bearings: Molded synthetic sleeve, turning in hole in duct.
   d. Axle: Minimum 3/8 inch square, plated steel, mechanically attached to blade.
   e. Mounting: Vertical or Horizontal.
3. Performance Data:
a. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
b. Leakage: Maximum 40 cubic feet per minute total at 1 inch w.g. for 20 inches wide.
c. Hand Quadrant Standoff Bracket: 2 inch standoff for insulated ductwork.
d. Oillite bearings.

2.4 CONTROL DAMPERS
A. Automatic control dampers furnished by Division-23 “Instrumentation and Controls for HVAC”

2.5 FIRE DAMPERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Arrow United Industries; a Division of Mestek, Incorporated
   2. Cesco Products; a Division of Mestek, Incorporated.
   4. Pottorff; Division of PVI Industries Incorporated
   5. Prefco; Perfect Air Control, Incorporated
   6. Ruskin Company.
   7. Vent Products Company, Incorporated
   8. Greenheck.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 3000-fpm velocity.


E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 degrees F or 212 degrees F rated, fusible links based on application.

2.6 SMOKE DAMPERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Arrow United Industries; a Division of Mestek, Incorporated
   2. Cesco Products; a Division of Mestek, Incorporated.
   4. Pottorff; Division of PVI Industries Incorporated
   5. Prefco; Perfect Air Control, Incorporated
   6. Ruskin Company.
   7. Vent Products Company, Incorporated
   8. Greenheck.

B. General Requirements: Label according to UL 555S by an NRTL.
1. Frame: Hat-shaped, 0.044-inch-thick, galvanized sheet steel, with welded and mounting flange.
2. Blades: Roll-formed, horizontal, overlapping, 0.063-inch-thick, galvanized sheet steel.
3. Leakage: Class 3.
4. Rated pressure and velocity to exceed design airflow conditions.
5. Mounting Sleeve: Factory-installed, 0.063 thick, galvanized sheet steel; length to suit wall or floor application.
7. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven loads will not require motor to operate in service factor range above 1.0.
   b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230900 "Instrumentation and Control for HVAC."
   c. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   d. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. X lbf and breakaway torque rating of 150 in. X lbf.
   e. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
   f. Non-spring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. X lbf and breakaway torque rating of 300 in. X lbf.
   g. Electrical Connection: Refer to Division 26 drawings.
8. Accessories:
   a. Auxiliary switches for position indication on building automation system.

2.7 COMBINATION FIRE AND SMOKE DAMPERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Arrow United Industries; a Division of Mestek, Incorporated
   2. Cesco Products; a Division of Mestek, Incorporated.
   4. Pottorff; Division of PVI Industries Incorporated
   5. Prefco; Perfect Air Control, Incorporated
   6. Ruskin Company.
   7. Vent Products Company, Incorporated
   8. Greenheck.
B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
   1. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
   2. Fire Rating: 1-1/2 and 3 hours. Refer to drawings.
   3. Frame: Hat-shaped, 0.063-inch-thick, galvanized sheet steel, with welded and mounting flange.
   7. Leakage: Class I.
   8. Rated pressure and velocity to exceed design airflow conditions.
   9. Mounting Sleeve: Factory-installed, 0.039-inch-thick, galvanized sheet steel; length to suit wall or floor application.
11. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230900 "Instrumentation and Control for HVAC."
   c. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   d. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
   e. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
   f. Non-spring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
   g. Electrical Connection: Refer to Division 26 drawings.

12. Accessories:
   a. Auxiliary switches for position indication on building automation system.

2.8 FLANGE CONNECTORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Incorporated
   2. Elgin Manufacturing
   3. Nexus PDQ; Division of Shilco Holdings Incorporated
   4. Ward Industries, Incorporated; a Division of Hart & Cooley, Incorporated

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.9 DUCT SILENCERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Industrial Noise Control, Incorporated
   2. McGill AirFlow LLC.
   3. Price Industries
   4. Ruskin Company.
   5. Semco Incorporated.
   6. VAW Systems Ltd.

B. Source Quality Control:
   1. Acoustic Performance: Test according to ASTM E 477. Acoustic performance tests shall be performed and certified by an independent testing agency.
   2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with airflow of at least 2000-fpm face velocity.
   3. Leak Test: Test units for air tightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

C. General Requirements:
   1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.

3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Shape:
   1. Rectangular straight with splitters or baffles.

E. Rectangular Units: Fabricate casings with a minimum of 0.034-inch-thick, solid galvanized sheet metal for outer casing and 0.022-inch-thick, ASTM A 653/A 653M, G60, perforated galvanized sheet metal for inner casing. Casings shall not fail under 8 inches of differential air pressure.

F. Sheet Metal Perforations: 1/8-inch diameter for inner casing and baffles sheet metal.

G. Fill Material: Inert and vermin-proof fibrous material packed under not less than 15 percent compression.
   1. Erosion Barrier: Polymer bag enclosing fill and heat-sealed before assembly.

H. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.
   1. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
   2. Lock form and seal or continuously weld joints.
   3. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
   4. Reinforcement: Cross or trapeze angles for rigid suspension.

I. Connection Sizes: Match connecting ductwork unless otherwise indicated.

J. Capacities and Characteristics:
   1. Refer to Duct Silencer Schedule for capacities and characteristics.

2.10 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Incorporated
   2. Elgin Manufacturing
   3. Duro Dyne Incorporated
   4. METALAIRE, Incorporated
   5. SEMCO Incorporated.
   7. Ward Industries, Incorporated; a Division of Hart & Cooley, Incorporated

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

D. Vane Construction: Single wall for ducts up to 24 inches wide and double wall for larger dimensions.

2.11 REMOTE MANUAL DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff; a Division of PCI Industries, Incorporated
   2. Ventfabrics, Incorporated
   3. Young Regulator Company.
4. Ruskin
5. Greenheck

B. Description: Concealed damper regulator with cover, cable, damper, and damper operator.
   1. Damper Operator: 9 volt DC actuator with RJ-11 connection.
   2. Cable: Flexible rotating cable up to 30-feet in length. RJ-11 plenum rated cable.
   3. Remote Operator: RC-9V handheld remote damper controller
   4. Cover Plate: Removable flush mounted cover plate up to 3-inches in diameter conceals remote operator.
   5. Factory primer coat cover plate for field painting according to requirements of Division 9.

2.12 DUCT-MOUNTED ACCESS DOORS
A. General Description: Fabricate doors airtight and suitable for duct pressure class.
B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where access door located within 3’ of connected equipment. Include 1-by-1-inch butt or piano hinge and cam latches.
   1. Manufacturers:
      a. American Warming and Ventilating.
      b. CESCO Products.
      c. Ductmate Industries, Incorporated
      d. Flexmaster U.S.A., Incorporated
      e. Greenheck.
      g. Nailor Industries Incorporated
      h. Pottorff; Division of PVI Industries Incorporated
      i. Ventfabrics, Incorporated
      j. Ward Industries, Incorporated
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Provide number of hinges and locks as follows:
      a. Less Than 12 Inches square: Secure with two sash locks.
      b. Up to 18 Inches Square: Two hinges and two sash locks.
      c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside handles.
      d. Sizes 24 by 48 Inches and Larger: One additional hinge.
   C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.
      1. Manufacturers:
         a. Flexmaster U.S.A., Incorporated
      2. Frame: Galvanized sheet steel, with spin-in notched frame.
   D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
   E. Insulation: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.13 FLEXIBLE CONNECTORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Incorporated
   2. Duro Dyne Incorporated
   3. Ventfabrics, Incorporated
   4. Ward Industries, Incorporated; a Division of Hart & Cooley, Incorporated
   B. Materials: Flame-retardant or noncombustible fabrics.
   C. Coatings and Adhesives: Comply with UL 181, Class 1.
D. Metal-Edged Connectors: Factory fabricated with a fabric strip [3-1/2 inches] [5-3/4 inches] wide attached to 2 strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.

   1. Minimum Weight: 26 oz./sq. yd.
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

   1. Minimum Weight: 24 oz./sq. yd.
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.

G. High-Corrosive-Environment System, Flexible Connectors: Chemical-resistant industrial rubber.
   1. For use in fume hood exhaust system.
   2. Steel wire reinforced natural rubber with 1/16-inch thick molded “Teflon” liner and 1/8” thick rubber cover.
   3. Rated for 165 psi.
   4. Service Temperature: Minus 67 to plus 400 Degrees F.

2.14 FLEXIBLE DUCTS

A. Manufacturers:
   1. Ductmate Industries, Incorporated
   2. Flexmaster U.S.A., Incorporated
   3. Hart & Cooley, Incorporated
   5. Thermaflex

B. Insulated-Acoustical-Flexible Duct: UL 181, Class 1, spun bond nylon fabric liner supported by helically wound galvanized steel, mechanically fastened to fabric liner without use of adhesive. Fiberglass insulation R-6.0 with aluminized vapor barrier.
   1. Pressure Rating:
      a. Sizes 6-inches to 16-inches: 6-inch wg positive and 5-inch wg negative.
   3. Temperature Range: Minus 20 to plus 250 Degrees.
   4. Minimum Acoustic Performance:
      a. The insertion loss (dB) of a 6 foot length of duct when tested in accordance with ASTM E 477 at a velocity of 1000 feet per minute shall be at least:

      | Frequency | 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz |
      |-----------|-------|-------|-------|--------|--------|--------|
      | 8 inch dia. | 11    | 20    | 27    | 31     | 26     | 12     |
      | 12 inch dia. | 10    | 17    | 23    | 30     | 18     | 9      |

C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.15 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.
PART 3 EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories according to the manufacturers published installation instructions.

C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
   1. Duct openings shall be free of any obstruction or irregularities that interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure 1/4" larger than damper dimensions and shall be square, straight, and level.
   2. Multiple damper sections will be square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be equal ±1/8-inches.
   3. Install extended shaft or jackshaft per manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
   4. Damper blades, axles, and linkage shall operate without binding. Before system operation, cycle damper after installation to assure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
   5. Provide a visible and accessible indication of damper position on the drive shaft end.
   6. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

D. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

E. Coordinate the installation of duct accessories with the work of other trades. Plan and maintain access for the installation, inspection and operation of dampers. Access for fire and smoke dampers will be as required by the installation instructions, but not less than a 2'-0" x 2'-0" clear access space to the duct access door and/or damper actuator.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install outside air static pressure probe according to the manufactures instructions.

3.2 BACKDRAFT DAMPERS

A. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on the drawings. Backdraft dampers shall be eliminated when "automatic control dampers" are indicated to prevent back drafts.

3.3 MANUAL VOLUME DAMPERS

A. In ducts with liner, install volume dampers in ducts so as to avoid damage to and erosion of duct liner.

B. Install manual volume dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff. Install manual volume dampers as indicated on the Drawings and Details, and as necessary to accomplish system air balancing. As a minimum, manual volume dampers will be provided at every divided flow main or branch duct, at every branch duct take off, and every duct extending to individual register, grille, or diffuser. Manual volume dampers are not required upstream of variable volume air terminal units.
   1. Install remote damper operators for volume dampers located above gypsum board, plaster, and other hard ceilings.
C. Set dampers to fully open position before testing, adjusting, and balancing.

3.4 DUCT SILENCERS

A. Install duct silencers independent of ducts with flexible duct connectors. Install duct silencers with splitter elements arranged vertically wherever possible. Where elbows precede silencers, splitter elements will be installed parallel to the plane of the elbow. Maintain minimum straight duct lengths upstream and downstream of fans, system components, and duct elbows and fittings as recommended by manufacturer to achieve 1.0 multiplier on published straight duct silencer air pressure drop.

3.5 DUCT ACCESS DOORS

A. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. At outdoor-air intakes and mixed-air plenums.
   3. At drain pans and seals.
   4. Upstream from duct filters.
   5. Upstream and downstream from duct filters.
   6. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   7. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links. Access doors for access to fire dampers having fusible links shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   8. Upstream or downstream from duct silencers.
   9. Control devices requiring inspection.
   10. Elsewhere as indicated.

B. Install access doors with swing against duct static pressure.

C. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.

D. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

3.6 FLEXIBLE CONNECTORS

A. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

B. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

C. Install flexible connectors for fume hood exhaust systems according to the connector manufacturer’s installation instructions.

D. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.
3.7 **INSTALLATION OF FLEXIBLE DUCTS**

A. Install and flexible ducts according to the manufacturer's instructions, applicable SMACNA standards, drawing details, and as follows:

1. Duct Collars: Provide tap-in collars 4-inches minimum in length with a formed bead 1-inch from the end for attachment of flexible duct. Extend minimum collar length for manual volume dampers.
2. Connections: Attach flexible duct to the tap-in collars and to sleeves with a duct clamp (draw band) around the inner liner and a second draw band around the insulation jacket. Position duct clamps behind the beads on the collar or sleeve. Duct clamps may be screwed stainless steel bands or nylon straps tightened with a compression tool.
3. Duct Supports: Support flexible duct at the manufacturer's recommended interval, but not less than every 5 feet. Maximum permissible sag is 1/2-inch per foot of spacing between supports (maximum of 1-1/4-inches over five feet).
4. Duct Hangers: Provide hanger straps in contact with the flexible duct at least 2-inch wide so the internal diameter of the duct is not reduced at the point of support.
5. Duct Bends: Make bends or turns in flexible ducts with not less than a one-duct diameter throat radius.
6. Connect diffusers, registers, grilles, and light troffer boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place. Refer to drawing details for additional requirements.

3.8 **FIRE DAMPERS**

A. Install fire dampers according to manufacturer's UL-approved written instructions. Refer to the architectural drawings for fire rating requirements. Provide 1-1/2 hour rated fire dampers for wall and floor assemblies rated for 3 hours or less. Provide 3 hour rated fire dampers for wall and floor assemblies rated for more than 3 hours. Fire dampers will have 165-degree F links except as noted.

3.9 **SMOKE DAMPERS**

A. Install smoke dampers, and combination fire/smoke dampers according to manufacturer's UL-approved written instructions. Refer to the architectural drawings for fire rating requirements. Provide 1-1/2 hour rated dampers for wall and floor assemblies rated for 3 hours or less. Provide 3 hour rated combination dampers for wall and floor assemblies rated for more than 3 hours. Combination dampers will have 165-degree F links except as noted.

1. Refer to the damper schedule for additional data.
2. Coordinate the installation of duct smoke detectors provided by Division 26. Duct smoke detectors must be installed in an accessible location in accordance with the manufacturer’s instructions and the UL listing.

3.10 **FIELD QUALITY CONTROL**

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION
SECTION 23 33 05
NOISE CONTROL ACCESSORIES FOR DUCTWORK

PART 1 GENERAL

1.1 SCOPE
A. This section includes:
   1. Duct silencers
   2. Acoustically-rated flexible ducts
   3. Lagging wrap

1.2 RELATED SECTIONS
A. Division 1 – General Acoustical Requirements
B. Division 7 – Sealants

1.3 REFERENCES
A. American Society for Testing and Materials:
   3. E413-87 – Classification for Rating Sound Insulation

1.4 QUALIFICATIONS
A. Installer: Company specializing in performing the work of this Section with minimum 3 years documented experience.

1.5 REGULATORY REQUIREMENTS
A. Ductwork accessory components and installation to conform to applicable building codes

1.6 PERFORMANCE REQUIREMENTS
A. Noise control accessories in the path of airflow to meet minimum performance as indicated in the Contract Documents, when tested in accordance with ASTM E477-13e1.
B. Noise control accessories creating a barrier between noise producing elements and occupied building spaces to meet minimum performance as indicated in the Contract Documents, when tested in accordance with ASTM E90-97 for classification under ASTM E413-87.
C. Noise control performance of duct accessories may exceed the minimum DIL and TL ratings if required to meet other requirements of this section.
1.7 SUBMITTALS
A. Submit manufacturer's data, shop drawings, and product performance certifications in accordance with specified requirements.
B. Submit technical product data indicating acoustic performance as follows:
   1. Duct Silencers
      a. Dynamic Insertion Loss at the specified airflow in octave bands from 63Hz to 4000Hz.
      b. Self-Generated Noise, reported as sound power level, at the specified airflow in octave bands from 63Hz to 4000Hz.
      c. Static pressure drop at the specified airflow, including the effects of duct configurations proximate to the inlet and outlet of the silencer (i.e. “system effects”)
      d. Sheet metal gauge for silencer casing.
   2. Acoustically-Rated Flexible Ducts
      a. Dynamic Insertion Loss per linear foot of duct in octave bands from 125Hz to 4000Hz.
   3. Lagging Wrap
      a. Transmission Loss in octave bands from 125Hz to 4000Hz.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site under provisions of Division 1.
B. Store and protect products under provisions of Division 1.

PART 2 PRODUCTS

2.1 DUCT SILENCERS
A. Duct silencers to be comprised of solid steel casings, perforated sheet metal liners and baffles, and fiberglass fill.
   1. Casing construction:
      a. Standard casing: Minimum 18ga. galvanized sheet steel
      b. High Transmission Loss casing, where noted in the drawings: Minimum 16ga. galvanized sheet steel
   2. Baffle construction:
      a. Perforated facing: Minimum 26ga. galvanized sheet steel
      b. Where indicated on the drawings, encapsulate the fiberglass fill in a polymer or polyester film.
B. Minimum Dynamic Insertion Loss, Self-Generated Noise, and maximum permissible static pressure drop as indicated in the drawings.
C. The precise model of silencer may be selected by the manufacturer to meet the performance requirements as specified in the drawings, within the space allotted for the silencer as indicated in the drawings. Acceptable manufacturers:
   1. Vibro-Acoustics
   2. Price Industries
   3. VAW Systems
2.2  ACOUSTICALLY-RATED FLEXIBLE DUCTS

A. Acoustically-rated flexible ducts to be comprised of a perforated aluminum, chlorinated polyethylene (CPE), spunbond nylon, or other suitably acoustically-transmissive inner face bonded to a wire helix, a fiberglass insulation blanket wrap, and an outer aluminum or metalized film jacket.

B. Maximum length of flexible duct to be 3ft. (1m) except where indicated otherwise in the drawings. In no case should the length exceed applicable local code restrictions.

C. Minimum Dynamic Insertion Loss (dB per linear foot) with no airflow at 6in. (150mm) diameter:

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<th>Frequency (Hz)</th>
<th>125 Hz</th>
<th>250 Hz</th>
<th>500 Hz</th>
<th>1kHz</th>
<th>2kHz</th>
<th>4kHz</th>
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<td>4.2</td>
<td>3.0</td>
<td>2.0</td>
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</table>

D. Acceptable products:
1. T/L-A-T/L - Triple Lock Acoustic Duct Flexmaster Alpha by Novaflex
2. MK-E by Thermaflex
3. 6M by Flexmaster

2.3 LAGGING WRAP

A. Wrap:
1. Lagging wrap to be comprised of mass loaded vinyl of 1 psf surface weight with fiberglass mesh reinforcing.
   a. Minimum operating temperature range of -40 degrees Fahrenheit to 180 degrees Fahrenheit
   b. Resistant to water, oil, fungi, weak acids and alkalis.
   c. Minimum transmission loss values (dB):

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>125 Hz</th>
<th>250 Hz</th>
<th>500 Hz</th>
<th>1kHz</th>
<th>2kHz</th>
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<td>21</td>
<td>28</td>
<td>33</td>
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<td>26</td>
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</table>

2. Acceptable products include:
   a. KNM-100RB by Kinetics Noise Control
   b. UN-10R by Unger
   c. AudioSeal AB10R by Acoustical Solutions

B. Insulation
1. Glass fiber, mineral fiber or polyurethane foam insulation with density of 1.5pcf to 3pcf (24 to 48 kg/m³).
2. Insulation type to meet required thermal and fire ratings as indicated in the drawings.
3. Thickness of insulation varies depending on the size of the element being wrapped in lagging material, refer to Part 3 of this specification.

C. Joint tape:
1. Tape as recommended by lagging wrap manufacturer to seal joints and edges as required.
PART 3 EXECUTION

3.1 EXAMINATION
A. Verify that field conditions are acceptable and are ready to receive work.
B. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION
A. Duct Silencers, Acoustically-Rated Louvers, Acoustically-Rated Transfer Ducts, Acoustically-Rated Flexible Ducts, and Acoustically-Rated Return Air Boots:
   1. Follow all manufacturer’s instructions for material handling and installation.
   2. Follow the standards for installation of sheet metal ductwork and other duct accessories as described elsewhere in the Contract Documents
B. Lagging Wrap
   1. Follow all manufacturer’s instructions for material handling and installation.
   2. For piping and ductwork with risk of condensation within the external insulation, spray-apply vapor absorber to the outside of the element before installing insulation or utilize polyethylene sheet as a vapor barrier.
   3. Insulation around the outside of the element.
      a. Use insulation of the following thickness where the following does not interfere with thermal or fire ratings:
         1) Use 1 inch thick insulation for piping of 3 inch and smaller diameter and ductwork of 144 square inches or less in free area.
         2) Use 2 inch insulation for larger piping and ductwork.
      b. Use insulation compatible with required fire ratings and thermal insulation as defined in the drawings and elsewhere in the specifications, when this differs from the thickness described above.
   4. Wrap each element individually and continuously on all sides with a minimum overlap of 2 inches at seams.
      a. Tape all seams airtight using tape recommended by the lagging manufacturer. Do not use duct tape for this purpose.
      b. If clearance above the element to the underside of the structural deck does not permit installation of the lagging between the element and the deck, request direction from the Acoustics Consultant.
      c. If the lagging material needs to be field-cut to fit, dress the edges of the material according to manufacturer’s instructions prior to installation.
   5. Install a second layer of the lagging where indicated in the drawings. Stagger seams not less than 12 inches from those of the first layer and tape as described above.
   6. All layers of lagging must extend for the full length of piping and ductwork scheduled for lagging, including elbows, branches, and terminal devices such as roof drains. Tape and seal the ends of the installation to perimeter walls and slabs.
   7. Cut in access flaps for valves, access panels, and other items requiring access. Tape edges of access flaps and indelibly label each flap for its purpose.

3.3 PERFORMANCE TESTING
A. Notify the Engineer when the installation is substantially complete so that performance testing may be scheduled in conjunction with final punch list review.
B. Performance testing to be performed by others.

END OF SECTION
SECTION 233416
CENTRIFUGAL HVAC FANS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes: For each product.
      1. Airfoil centrifugal fans.
      2. Backward-inclined centrifugal fans.

1.3 ACTION SUBMITTALS
   A. Acoustic Performance Submittal
      1. Contractor shall submit at the time of bidding the design sound power level of each air moving device as described in the Contract Documents. If the actual sound power generated by any device exceeds in any octave band the specified sound power levels for the equipment specified in the Contract Documents, the contractor shall include in his price system modifications as required to compensate for the additional noise at no expense to the Owner. Any such system modification shall be subject to review and approval.
      2. Air moving devices (Supply, return and exhaust fans, package AHU’s): Submit sound power levels in octave bands from 63 Hz through 8000 Hz inclusive for the operating conditions specified. Data shall be obtained in accordance with AMCA 300-85. If fans are variable speed, provide sound power level data for maximum rpm and also at 80% and 60% of maximum rpm. Provide discharge, inlet and case-radiated sound power data for all fans.
      3. Submit for each fan a performance curve showing the operating point for which the acoustical data has been provided.
   B. Product Data:
      1. Include rated capacities, furnished specialties, and accessories for each fan.
      2. Certified fan performance curves with system operating conditions indicated.
      3. Certified fan sound-power ratings.
      4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
      5. Material thickness and finishes, including color charts.
      6. Dampers, including housings, linkages, and operators.
   C. Shop Drawings:
      1. Include plans, elevations, sections, and attachment details.
      2. Include details of equipment assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
      3. Include diagrams for power, signal, and control wiring.
      4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
      5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
1.4 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
   B. Field quality-control reports.
   C. Field Startup Reports.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS
   A. Belts: One set for each belt-driven unit.

1.7 COORDINATION
   A. Coordinate size and location of structural-steel support members.
   B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. AMCA Compliance:
      1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
      2. Operating Limits: Classify according to AMCA 99.
   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   C. Capacities and Characteristics:
      1. Refer to centrifugal fan schedule on the drawings for capacities and characteristics.

2.2 AIRFOIL CENTRIFUGAL FANS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Twin City Fan
      2. Greenheck
      3. Loren Cook Company
   B. Description:
      1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
      2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
      3. Factory-installed and -wired disconnect switch.
   C. Housings:
      1. Formed panels to make curved-scroll housings with shaped cutoff.
      2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
      3. Spun inlet cone with flange.
      4. Outlet flange.
   D. Airfoil Wheels:
2. Heavy backplate.
3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Grease-Lubricated Shaft Bearings:
1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
2. Ball-Bearing Rating Life: ABMA 9 L10 at 200,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, L10 at 200,000 hours.

G. Belt Drives:
1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size 25 horsepower and smaller: 1.2
3. Service Factor Based on Fan Motor Size greater than 25 horsepower: 1.5
4. Fan Pulleys: Cast iron or cast steel with split tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
6. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
7. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

H. Accessories:
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Inlet Screens: Grid screen of same material as housing.
5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
9. Piezo ring airflow measuring device.

2.3 BACKWARD-INCLINED CENTRIFUGAL FANS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Twin City Fan
2. Greenheck
3. Loren Cook Company

B. Description:
1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Housings:
1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Spun inlet cone with flange.
4. Outlet flange.

D. Backward-Inclined Wheels:
1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.

E. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Grease-Lubricated Shaft Bearings:
1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
2. Ball-Bearing Rating Life: ABMA 9, L10 at 200,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, L10 at 200,000 hours.

G. Belt Drives:
1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size 25 horsepower and smaller: 1.2
3. Service Factor Based on Fan Motor Size greater than 25 horsepower: 1.5
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
6. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
7. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

H. Accessories:
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
5. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
7. Piezo ring airflow measuring device.
2.4 MOTORS
   A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   B. Shaft: Grounded
      1. Provide Aegis SGR or approved equivalent for shaft grounding.
      2. Install per manufacturer instructions.

2.5 SOURCE QUALITY CONTROL
   A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
   B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

2.6 ELECTRICAL CONNECTION
   A. For all fans, refer also to Electrical Coordination schedule for electrical connection requirements. Electrical connection requirements include, but are not limited to, variable speed drives, disconnects, voltage, controls/switching.

2.7 BUILDING AUTOMATION SYSTEM INTERFACE
   A. Refer also to Sequence of Operation for necessary control and interface requirements.

PART 3 EXECUTION

3.1 INSTALLATION
   A. Install centrifugal fans level and plumb.
   B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
   C. Lift and support units with manufacturer's designated lifting or supporting points.
   D. Equipment Mounting:
      1. Install centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-In-Place Concrete."
      2. Comply with requirements for vibration isolation devices specified in Section 230548 "Noise and Vibration Controls for HVAC."
   E. Unit Support: Install centrifugal fans level on structural pilings. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.
   F. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration isolation and seismic-control devices.
      1. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.
      2. Comply with requirements in Section 230548 "Noise and Vibration Controls for HVAC"
   G. Install units with clearances for service and maintenance.
   H. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
3.2 CONNECTIONS
A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
B. Install ducts adjacent to fans to allow service and maintenance.
C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

3.3 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
C. Perform the following tests and inspections:
1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
10. Remove and replace malfunctioning units and retest as specified above.
D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports.

3.4 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION
SECTION 233423
HVAC POWER VENTILATORS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Centrifugal roof ventilators.
   2. In-line centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS
A. Project Altitude: Base fan-performance ratings on actual project site elevation.
B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS
A. Acoustic Performance Submittal
   1. Contractor shall submit at the time of bidding the design sound power level of each air moving device as described in the Contract Documents. If the actual sound power generated by any device exceeds in any octave band the specified sound power levels for the equipment specified in the Contract Documents, the contractor shall include in his price system modifications as required to compensate for the additional noise at no expense to the Owner. Any such system modification shall be subject to review and approval.
   2. Air moving devices (Supply, return and exhaust fans, package AHU's): Submit sound power levels in octave bands from 63 Hz through 8000 Hz inclusive for the operating conditions specified. Data shall be obtained in accordance with AMCA 300-85. If fans are variable speed, provide sound power level data for maximum rpm and also at 80% and 60% of maximum rpm. Provide discharge, inlet and case-radiated sound power data for all fans.
   3. Submit for each fan a performance curve showing the operating point for which the acoustical data has been provided.

B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.
D. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.5 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Roof framing and support members relative to duct penetrations.
   2. Ceiling suspension assembly members.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
B. Field quality-control reports.
C. Startup Reports.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Belts: One set for each belt-driven unit.

1.8 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.
D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

1.9 COORDINATION
A. Coordinate size and location of structural-steel support members.
B. Coordinate sizes and locations of concrete bases with actual equipment provided.
C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
D. Coordinate motor control requirements with building automation system installer.
PART 2 PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aerovent (Twin City Fan) (www.aerovent.com)
   2. Greenheck (www.greenheck.com)
   3. Loren Cook Company. (www.lorencook.com)
   4. PennBarry. (www.pennbarry.com)

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
   1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
   2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Direct Drives:
   1. Motors: Electronically commutated brushless DC single phase.
   2. Motor speed control:
      a. Motor mounted manual speed control adjustment dial; 350 RPM to 1725 RPM.

E. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   5. Fan and motor isolated from exhaust airstream.

F. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
   3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
   5. Motor starter
   6. Manufacturer’s standard protective coating.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   1. Configuration: Self-flashing without a cant strip, with mounting flange.
   2. Overall Height: Minimum 16 inches.
   3. Sound Curb: Curb with sound-absorbing insulation.
   4. Vented Curb: Unlined with louvered vents in vertical sides. – for high temperature exhaust only

H. Capacities and Characteristics:
   1. Refer to fan schedule on the drawing for capacities and characteristics.

2.2 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aerovent (Twin City Fan) (www.aerovent.com)
   2. Greenheck (www.greenheck.com)
   3. Loren Cook Company. (www.lorencook.com)
B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Companion Flanges: For inlet and outlet duct connections.
   3. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
   4. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
   5. Motor starter.

G. Capacities and Characteristics:
   1. Refer to schedule on the drawings for capacities and characteristics.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

C. Shaft: Grounded – for all motors on variable frequency drives.
   1. Provide Aegis SGR or approved equivalent for shaft grounding.
   2. Install per manufacturer instructions.

2.4 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

2.5 ELECTRICAL CONNECTION

A. For all fans, refer also to Electrical Coordination schedule for electrical connection requirements. Electrical connection requirements include, but are not limited to, variable speed drives, disconnects, voltage, controls/switching.

2.6 BUILDING AUTOMATION SYSTEM INTERFACE

A. Refer also to Sequence of Operation for necessary control and interface requirements.
PART 3 EXECUTION

3.1 INSTALLATION
A. Install power ventilators level and plumb.
B. Install power ventilator accessories.
C. Equipment Mounting:
   1. Install floor mounted power ventilators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
D. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.
E. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
F. Support suspended units from structure using threaded steel rods and vibration isolators; refer to the drawings for isolator deflection and type of isolator required. Vibration-control devices are specified in Division 23 Section "Vibration And Seismic Controls For HVAC Piping And Equipment."
G. Install units with clearances for service and maintenance.
H. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS
A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
B. Install ducts adjacent to power ventilators to allow service and maintenance.
C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL
A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
B. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.
   7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
D. Prepare test and inspection reports.
E. Submit startup reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.
B. Adjust belt tension.
C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
D. Replace fan and motor pulleys as required to achieve design airflow.
E. Lubricate bearings.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Shutoff, single-duct air terminal units.
   2. Fan-powered air terminal units.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
   1. Air terminal units.
   2. Liners and adhesives.
   3. Sealants and gaskets.
   4. Submit shop drawings complete with sound power levels generated by each terminal device at the air flow and pressure drop specified in the contract documents.
B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Hangers and supports, including methods for duct and building attachment and vibration isolation.
C. Acoustic Submittal
   1. Unit manufacturer shall furnish when requested certified sound power levels for both discharged air and casing radiated sound in each of the second through sixth octave bands for every unit furnished with inlet pressures of 3/4", 1-1/2" and 3" w.g. determined in accordance with ASHRAE Standard 36-72, latest publication.
D. Delegated-Design Submittal:
   1. Materials, fabrication, assembly, and spacing of hangers and supports.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Size and location of initial access modules for acoustic tile.
   3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
B. Field quality-control reports.
1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 “Operation and Maintenance Data,” include the following:
   1. Instructions for resetting minimum and maximum air volumes.
   2. Instructions for adjusting software set points.

1.6 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - “Systems and Equipment” and Section 7 - “Construction and System Start-Up.”

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   1. Environmental Technologies, Inc. (www.enviro-tec.com)
   3. Titus (www.titus-hvac.com)
   4. Trane (www.trane.com)

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: Minimum 0.034-inch steel single wall.
   1. Casing Lining: Adhesive attached, 1/2-inch-thick, polyurethane foam insulation complying with NFPA 90A and UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

E. Attenuator Section: 0.034-inch steel sheet. – For boxes scheduled with an attenuator
   1. Lining: Adhesive attached, 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
      a. Cover liner with nonporous foil and perforated metal.
   2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
   1. Minimum 2-rows.

G. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230900 "Instrumentation and Control for HVAC."

H. Capacities and Characteristics
   1. Refer to equipment schedules for capacities and characteristics.

2.3 PARALLEL FAN-POWERED AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   1. Environmental Technologies, Inc (www.enviro-tec.com)
   3. Titus (www.titus-hvac.com)
   4. Trane (www.trane.com)

B. Configuration: Volume-damper assembly and fan in parallel arrangement inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch steel single wall.
   1. Casing Lining: Adhesive attached, 1-inch-thick, polyurethane foam insulation complying with NFPA 90A, UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
   5. Fan: Forward-curved centrifugal, located at plenum air inlet.
   6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch wg inlet static pressure.

E. Velocity Sensors: Multipoint array with velocity sensors in cold- and hot-deck air inlets and air outlets.

F. Direct Drive:
   1. Motors: Electronically commutated brushless DC single phase.
      a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      b. Motor Bearings: Ball type.
      c. Fan-Motor Assembly Isolation: Rubber isolators.
   2. Motor speed control:
      a. External control signal 0-10 VDC; fan speed controlled by the building automation system

G. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Material: Pleated cotton-polyester media having 90 percent arrestance and 7 MERV.
   2. Thickness: 1 inch.
H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
   1. Minimum 2-rows.
   2. Location: Plenum air inlet.

I. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

J. Electronic Controls: Bidirectional damper operator and microprocessor-based controller with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Section 230900 "Instrumentation and Control for HVAC” and shall have the following features:
   1. Occupied and unoccupied operating mode.
   2. Remote reset of airflow or temperature set points.
   3. Adjusting and monitoring with portable terminal.
   4. Communication with temperature-control system specified in Section 230900 “Instrumentation and Control for HVAC.”

K. Capacities and Characteristics
   1. Refer to equipment schedules for capacities and characteristics.

2.4 HANGERS AND SUPPORTS
   A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
   B. Hanger Rods for Corrosive Environments: Electro galvanized all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
   C. Steel Cables: Galvanized steel complying with ASTM A 603 or Stainless steel complying with ASTM A 492.
   D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
   E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
   F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.5 SOURCE QUALITY CONTROL
   A. Factory Tests: Test assembled air terminal units according to ARI 880.
      1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

2.6 ELECTRICAL CONNECTION
   A. Refer also to Mechanical Electrical Coordination schedule for electrical connection requirements including but not limited to starters, disconnects, wiring, installation, interconnections, etc.

PART 3 EXECUTION

3.1 INSTALLATION
   A. Install air terminal units according to NFPA 90A, “Standard for the Installation of Air Conditioning and Ventilating Systems” and the manufacturers installation instructions.
B. Install air terminal units’ level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install return air inlet sound attenuator on fan powered air terminal units.

3.2 HANGER AND SUPPORT INSTALLATION
A. Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS
A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," connect heating coils to supply with shutoff valve, strainer, control valve, And air vent; and to return with balancing.
   1. Connect steel heating-coil supply and return piping with union or flange. Copper piping connections do not require unions or flanges.

C. Connect ducts to air terminal units according to Section 233113 "Metal Ducts."

D. Make supply duct connections to fan powered air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.4 IDENTIFICATION
A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
   1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.
3.6 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer’s written instructions.
   2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   3. Verify that controls and control enclosure are accessible.
   4. Verify that control connections are complete.
   5. Verify that nameplate and identification tag are visible.
   6. Verify that controls respond to inputs as specified.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Round ceiling diffusers.
   2. Rectangular and square ceiling diffusers.
   3. Louver face diffusers.
   4. Linear bar diffusers.
   5. Linear slot diffusers.
   6. Ceiling-integral continuous diffusers.
   7. Adjustable bar registers and grilles.
   8. Fixed face registers and grilles.
   9. Linear bar grilles.

B. Related Sections:
   1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, mounting surface, border, frame, and accessories furnished.

B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   5. Duct access panels.

B. Source quality-control reports.

1.5 COORDINATION
A. Review the architectural drawings for diffuser, register, and grille mounting surfaces.
PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Round Ceiling Diffuser:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the fol-
      lowing:
      a. Price Industries.
      b. Titus.
   2. Face Style: four cones.
   4. Accessories: Refer to the drawings and equipment schedules for accessories.
      a. Equalizing grid.
      b. Plaster ring.

B. Rectangular and Square Ceiling Diffusers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the fol-
      lowing:
      a. Price Industries.
      b. Titus.
   2. Face Style: three cones.
   3. Accessories: Refer to the drawings and equipment schedules for accessories.
      a. Equalizing grid.
      b. Plaster ring.

C. Louver Face Diffuser:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the fol-
      lowing:
      a. Price Industries.
      b. Titus.
   2. Accessories: Refer to the drawings and equipment schedules for accessories.
      a. Square to round neck adaptor.
      b. Adjustable pattern vanes.
      c. Equalizing grid.
      d. Plaster ring.

2.2 CEILING LINEAR SLOT OUTLETS

A. Linear Bar Diffuser:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the fol-
      lowing:
      a. Price Industries.
      b. Titus.

B. Linear Slot Diffuser:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the fol-
      lowing:
      a. Price Industries.
      b. Titus.

C. Ceiling-Integral Continuous Diffuser:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the fol-
      lowing:
      a. Price Industries.
      b. Titus.
2.3 REGISTERS AND GRILLES

A. Adjustable Blade Register:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Price Industries.
      b. Titus.
   2. Frame: Minimum 20 gauge steel.
   4. Damper Type: Adjustable opposed blade unless noted otherwise.

B. Adjustable Bar Grille:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Price Industries.
      b. Titus.
   2. Frame: Minimum 20 gauge steel.

C. Fixed Face Register:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Price Industries.
      b. Titus.
   3. Finish: As scheduled.
   4. Face Arrangement: Refer to register schedule.
   5. Core Construction: Refer to register schedule.
   6. Frame: Minimum 20 Gauge Steel.
   7. Mounting Frame: Refer to register schedule.
   9. Damper Type: Adjustable opposed blade, unless noted otherwise.

D. Fixed Face Grille:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Price Industries.
      b. Titus.
   3. Finish: As scheduled.
   4. Face Arrangement: Refer to grille schedule.
   5. Core Construction: Refer to grille schedule.
   6. Frame: Minimum 20 Gauge Steel.
   7. Mounting: Concealed.

E. Linear Bar Grille:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Price Industries.
      b. Titus.
   3. Finish: Anodized, color selected by architect.
   4. Face Arrangement: Refer to Grille schedule.
   5. Frame: Refer to Grille schedule.
   7. Damper Type: Adjustable opposed blade, unless noted otherwise.
2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Provide the appropriate mounting frame or border for each diffuser register or grille location. Verify ceiling grid type for lay-in type inlets and outlets. Non-lay-in diffusers, registers, and grilles will have frames or borders for surface mounting.

3.2 INSTALLATION

A. Diffuser, register, and grille sizes and locations are indicated on the drawings and schedules.

B. Install diffusers, registers, and grilles level and plumb.

C. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

E. Install equalizing grids on round neck ceiling diffusers with an inlet duct of less than one diameter in length.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION
SECTION 234100
PARTICULATE AIR FILTRATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
B. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.
   1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
   2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
C. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE
A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated.
B. Comply with ARI 850.
C. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.
D. Comply with NFPA 90A and NFPA 90B.

1.5 EXTRA MATERIALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Provide one complete set of filters for each filter or filter bank
   2. Provide one container of red oil for inclined manometer filter gage.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Filters, Electrostatic Air Cleaners, and Filter-Holding Systems:
      a. AAF International.
      b. Farr Co.
      c. Purafil, Inc.
2. Filter Gages:
   a. Airguard Industries, Inc.
   b. Dwyer Instruments, Inc.
   c. Or Approved Equal

2.2 TYPE “A” DISPOSABLE PLEATED FILTERS

A. Description: Factory-fabricated, pleated-type, disposable air filters with holding frames.

B. Media: Non-woven, reinforced cotton and synthetic fibrous material formed into deep V-shaped pleats and held by self-supporting wire frames. The filter will have a minimum 4.4 square feet of media area per square foot of face area.

C. Enclosing Frame: Nonflammable cardboard, with suitable fasteners and gaskets to hold the media and media frame and to prevent unfiltered air from passing between media frames and holding devices.

D. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

E. Capacities and Characteristics:
   1. UL rating: Class 2.
   2. Efficiency: MERV 8 ASHRAE Standard 52.2-2007
   3. Depth: 2-inches
   4. Maximum initial resistance to air flow at 500 fpm: Refer to equipment schedules
   5. Final resistance to air flow at 500 fpm: Refer to equipment schedules
   6. Refer to equipment schedules for additional requirements.

2.3 TYPE “C” EXTENDED-SURFACE, DISPOSABLE PANEL FILTERS

A. Description: Factory-fabricated, dry, deep pleated, high efficiency, filters with holding frames.

B. Media: Microfiber glass material formed into deep V-shaped pleats with a spacing of 10 pleats per inch and held by self-supporting Wire frames. The filter will have a minimum 25 square feet of media area per square foot of face area.

C. Enclosing Frame: Non metallic frame, with suitable fasteners and gaskets to hold the media and media frame and to prevent unfiltered air from passing between media frames and holding devices.

D. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

E. Capacities and Characteristics:
   1. UL rating: listed Class 2.
   2. Efficiency: MERV 13 ASHRAE Standard 52.2-2007
   3. Depth: 12-inches nominal
   4. Maximum initial resistance to air flow at 500 fpm: Refer to equipment schedules.
   5. Final resistance to air flow at 500 fpm: Refer to equipment schedules.
   6. Refer to equipment schedules for additional requirements.

2.4 TYPE “D” EXTENDED-SURFACE, DISPOSABLE PANEL FILTERS

A. Description: Factory-fabricated, dry, deep pleated, high efficiency, filters with holding frames.

B. Media: Microfiber glass material formed into deep V-shaped pleats with a spacing of 10 pleats per inch and held by self-supporting wire frames. The filter will have a minimum 25 square feet of media area per square foot of face area.

C. Enclosing Frame: Non metallic frame, with suitable fasteners and gaskets to hold the media and media frame and to prevent unfiltered air from passing between media frames and holding devices.
D. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

E. Capacities and Characteristics:
   1. UL rating: Listed Class 2.
   2. Efficiency: MERV 14 ASHRAE Standard 52.2-2007
   3. Depth: 12-inches nominal
   4. Maximum initial resistance to air flow at 500 fpm: Refer to equipment schedules.
   5. Final resistance to air flow at 500 fpm: Refer to equipment schedules.
   6. Refer to equipment schedules for additional requirements.

2.5 FRONT- AND REAR-ACCESS FILTER FRAMES

A. Framing System: Galvanized-steel or Aluminum framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and pre-punched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.

B. Prefilters: Incorporate a separate track with spring clips, removable from front or back.

C. Sealing: Factory-installed, positive-sealing device for each row of filters, to ensure seal between gasketed filter elements and to prevent bypass of unfiltered air.

2.6 SIDE-SERVICE HOUSINGS

A. Description: Factory-assembled, side-service housings, constructed of galvanized steel, with flanges to connect to duct system.

B. Prefilters: Integral tracks to accommodate 2-inch (50-mm) disposable or washable filters.

C. Access Doors: Continuous gaskets on perimeter and positive-locking devices. Arrange so filter cartridges can be loaded from either access door. Provide ribbed bagging rim behind access door and PVC bags, for bag-in, bag-out arrangement.

D. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2.7 FILTER GAGES

A. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
   1. Diameter: 4-1/2 inches.
   2. Range: 0- to 2.0-inch w.g

B. Manometer-Type Filter Gage: Molded plastic with epoxy-coated aluminum scale, logarithmic-curve tube gage with integral leveling gage, graduated to read from 0- to 3.0-inch w.g, and accurate within 3 percent of full scale range.

C. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum or plastic tubing, and 2- or 3-way vent valves, gage connections, and mounting bracket.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install filter and filter frames according to manufacturer’s written instructions.

B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

C. Install filters in position to prevent passage of unfiltered air.
D. Install filter gage for each filter bank.

E. Install filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

F. Coordinate filter installations with duct and air-handling unit installations.

3.2 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION
SECTION 235216
CONDENSING BOILERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes packaged, factory-fabricated and -assembled, gas-fired, condensing boilers, trim, and accessories for generating hot water.

1.3 ACTION SUBMITTALS
A. Product Data: Include performance data, operating characteristics, furnished specialties, factory provided control systems and accessories.
   1. Efficiency Curves: Submit efficiency curves for 100%, 60%, and 5% input firing rates at incoming water temperatures ranging from 60°F to 160°F.
   2. Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 GPM to maximum value of boiler.
   3. Performance at Altitude: Provide documentation indicating that systems and equipment meets performance requirements at project altitude.
B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
   1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
      a. Design Calculations: Calculate requirements for selecting vibration isolators for designing vibration isolation bases.
      b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
   2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Source quality-control reports.
B. Field quality-control reports.
C. Warranty: Special warranty specified in this Section.
D. Other Informational Submittals:

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete. 

B. Coordinate size and location of electrical connections.

C. Coordinate building automation system (BAS) interface.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Condensing Boilers:
   a. Leakage and Materials: 10 years from date of Substantial Completion.
   b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Non-prorated for five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 CONDENSING BOILERS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   1. Advanced Thermal Hydronics
   2. Lochinvar Corporation.
   3. Cleaver Brooks

B. Description: Factory-fabricated, -assembled, and -tested, condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

C. Heat Exchanger: The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig. Pressure Vessel: Carbon steel with welded heads and tube connections.

D. Burner: The boiler burner shall be capable of a 5-to-1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves.
   1. Natural gas, forced draft.
   2. Burner shall operate without exceeding 20ppm NOx.

E. Blower: Variable speed centrifugal fan to operate during each burner firing sequence and to pre-purge and post purge the combustion chamber.


G. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

H. Casing:
1. Jacket: Sheet metal with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Baked-enamel or Powder-coated protective finish.
4. Insulation: Minimum 2-inch-thick, mineral-fiber or polyurethane-foam insulation surrounding the heat exchanger.
6. Mounting base to secure boiler.

I. Characteristics and Capacities:
1. Refer to condensing boiler schedule on drawings for characteristics and capacities.

2.2 TRIM
A. Aquastat Controllers: Operating, firing rate, and high limit.
B. Safety Relief Valve: ASME rated.
C. Additional safety devices: Low gas pressure switch, air flow switch, low water cutoff, high temperature switch, and blocked flue detection.
D. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
E. Alarm Bell
F. Condensate Neutralization: Provide condensate neutralization kit per boiler. Each kit shall include capsule made from corrosion resistant materials with access/fill openings, neutralization, threaded inlet and outlet openings, and related clamps and fittings. Provide one additional set of replacement neutralization media per boiler.

2.3 CONTROLS
A. Boiler operating controls shall include the following devices and features:
   1. Control transformer.
   2. Set-Point Adjust: Set points shall be adjustable by building automation system and local overrides.
   3. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate and to reset supply-water temperature based on reset sequences.
      a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
   4. Outlet water temperature sensor, return water temperature sensor, flue temperature sensor, outdoor air sensor, low water flow protection and built-in adjustable freeze protection.
   5. Multi-Colored Graphic LCD display with Navigation Dial and Soft Keys for, password security, three loop temperature setpoints with individual outdoor air reset curves, pump delay with adjustable freeze protection, pump exercise, domestic hot water prioritization with DHW modulation limiting and USB PC port connection. The boiler shall be capable of controlling a variable speed boiler pump to keep a constant Delta T at all modulation rates. The boiler shall have the capability to accept a 0-10 VDC input connection for BMS control of modulation or setpoint, enable disable of the boiler, variable system pump signal and a 0-10VDC output of boiler modulation rate. The boiler shall have a built-in “Cascade” with sequencing options for “lead lag” or “efficiency optimized” modulation logic, with both capable of rotation while maintaining modulation of up to eight boilers without utilization of an external controller.
   6. Pump starter
   7. Valve proving switch
   8. Isolation valve wiring
   9. Supply voltage shall be 120 volt / 60 hertz / single phase.

B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

C. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.

1. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.4 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to nonfused disconnect switch.
5. Provide branch power circuit to each motor and to controls with a disconnect switch.
6. Provide each motor with overcurrent protection.

B. Refer to plans, schedules and Mechanical Electrical Coordination Schedules for additional details and responsibilities for electrical connection information, disconnects, starter, variable speed drives, and controls.

2.5 VENTING KITS

A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

B. Venting Kits shall be provided by boiler manufacturer or from a product represented by the manufacturer providing the boiler.

2.6 VENTING

A. Double-wall, 1” ceramic insulated combustion exhaust vent. The exhaust vent must be UL Listed for use with Category III and IV appliances and compatible with operating temperatures up to 480°F, positive pressure, condensing flue gas service. UL-listed vents of Al 29-4C stainless steel must be used with boilers.

B. Combustion-Air Intake: Double-wall, 1” ceramic insulated, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

C. Venting and combustion air shall be provided by boiler manufacturer or from a product represented by the manufacturer providing the boiler.
2.7 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
   1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Equipment Mounting:
   1. Install boilers level on cast-in-place concrete equipment base(s) with vibration isolation pads.

B. Install boilers, trim, controls, and vents according to the boiler manufacturer’s installation instructions.

C. Install gas-fired boilers according to NFPA 54.

D. Assemble and install boiler trim.

E. Install electrical devices furnished with boiler but not specified to be factory mounted.

F. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service.

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install thermometers on the supply and return water pipes near the boiler connections.

H. Install piping from safety relief valves to nearest floor drain.
I. Boiler Venting and Combustion Air Intake:
   1. Confirm location, elevation and alignment of exterior vent and intake connections with architecture before insulation.
   2. Install flue venting kit and combustion-air intake per boiler.
   3. Connect full size vents and combustion air intake to boiler connections.
   4. All venting, combustion air intake piping, fittings, accessories shall meet all boiler and venting manufacturer's recommendations.

J. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

L. Provide and install emergency boiler shutoff switch that shall deactivate boilers. Emergency boiler shutoff switch shall meet applicable ASME CSD-1 and local code requirements. Emergency boiler shutoff switch shall deactivate boilers and domestic water heaters. Provide and install all necessary wiring, relays, breakers, etc.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Perform installation and startup checks according to manufacturer's written instructions.
   2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
      b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."

END OF SECTION
SECTION 236423
SCROLL WATER CHILLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Packaged, air-cooled, variable speed, electric-motor-driven, scroll water chillers with remote evaporators.

1.3 ACTION SUBMITTALS
A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
   1. Performance at ARI standard conditions and at conditions indicated.
   2. Performance at ARI standard unloading conditions.
   3. Minimum evaporator flow rate.
   4. Refrigerant capacity of water chiller.
   5. Oil capacity of water chiller.
   6. Fluid capacity of evaporator.
   7. Minimum entering condenser-air temperature
   8. Performance at varying capacity with constant design entering condenser-air temperature. Repeat performance at varying capacity for different entering condenser-air temperatures from design to minimum in 10 degree F increments.
B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
   1. Assembled unit dimensions.
   2. Weight and load distribution.
   3. Required clearances for maintenance and operation.
   4. Size and location of piping and wiring connections.
   5. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural supports.
   2. Piping roughing-in requirements.
   3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
   4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
B. Certificates: For certification required in "Quality Assurance" Article.
C. Source quality-control test reports.
D. Startup service reports.
E. Warranty: Sample of special warranty.
1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. ARI Certification: Certify chiller according to ARI 590 certification program.
B. ARI Rating: Rate water chiller performance according to requirements in ARI 506/110, "Water Chilling Packages Using the Vapor Compression Cycle."
C. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.
D. ASHRAE/IESNA 90.1-2010 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
E. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
F. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

1.8 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided.
B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

1.9 WARRANTY
A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified period.
   1. Compressor Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
B. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.
C. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.
D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
E. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
F. Comply with NFPA 70.
G. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.
H. Operation Following Loss of Normal Power:
1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought online.

2. See drawings for equipment served by backup power systems.

3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

I. Outdoor Installations:

1. Chiller shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a 25-year period with minimal degradation due to exposure to outdoor ambient conditions.

2. Chillers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past 30-year period.

2.2 MANUFACTURED UNITS

A. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser with fans, electrical power, controls, and indicated accessories.

B. Sound-reduction package shall have the following:
   1. Acoustic enclosure around compressors.
   2. Reduced-speed fans with acoustic treatment.
   3. High-performance fan design to reduce sound.
   4. Designed to reduce sound level without affecting performance.

C. Security Package: Full unit louvered panels or security grilles with fasteners for additional protection of compressors, evaporator, and condenser coils. Grilles shall be coated for corrosion resistance and shall be removable for service access.

2.3 CABINET

A. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.

B. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.

C. Casing: Galvanized steel.

D. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.

2.4 COMPRESSOR-DRIVE ASSEMBLIES

A. Compressors:
   1. Description: Positive-displacement direct drive with hermetically sealed casing.
   2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
      a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.
   3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
      a. Digital compressor unloading is an acceptable alternative to achieve capacity control.
5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.
   a. Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.

   a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.

7. Compressor Acoustic Sound Blankets

B. Compressor Motors:
   1. Hermetically sealed and cooled by refrigerant suction gas.
   2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

C. Compressor Motor Controllers:
   1. Across the Line: NEMA ICS 2, Class A, full voltage, non-reversing.

2.5 REFRIGERATION

A. Refrigerant: R-410A. Classified as Safety Group A1 according to ASHRAE 34.

B. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

C. Refrigerant Circuit: Each circuit shall include an electronic or a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

D. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.
   1. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in each circuit in lieu of each compressor.

E. Pressure Relief Device:
   1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   2. Select and configure pressure relief devices to protect against corrosion and inadvertent re-release of refrigerant.
   3. ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger.

2.6 REMOTE EVAPORATOR

A. Brazed Plate:
   1. Direct-expansion, single-pass, brazed-plate design.
   2. Type 316 stainless-steel construction.
   4. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
   5. Inlet Strainer: Factory-furnished, 40 mesh strainer for field installation in supply piping to evaporator. Manufacturer has option to factory install strainer.

B. Flow Switch: Factory-furnished, flow switch wired to chiller operating controls.

C. Remote-Mounting Kit: Designed for remote field mounting where indicated. Provide kit for field installation. 

Scroll Water Chillers
2.7 **AIR-COOLED CONDENSER**

A. Coil(s) with integral subcooling on each circuit.

B. Copper Tube with Plate Fin Coils:
   1. Construct coils of copper tubes mechanically bonded to aluminum > aluminum with precoated epoxy-phenolic copper fins.

C. Aluminum Microchannel Coils:
   2. Single- or multiple-pass arrangement.
   3. Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.

D. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

E. Fans: Low-sound fans and direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

F. Fan Motors: TENV or TEAO enclosure, with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
   1. Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.

G. Fan Guards: Removable steel safety guards with corrosion-resistant PVC coating.

2.8 **INSULATION**

A. Closed-cell, flexible, elastomeric thermal insulation complying with ASTM C 534/C 534M, Type I for tubular materials and Type II for sheet materials.
   1. Thickness: 1-1/2 inch.

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
   1. Apply adhesive to 100 percent of insulation contact surface.
   2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
   3. Seal seams and joints to provide a vapor barrier.
   4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
   5. Manufacturer has option to factory or field insulate chiller components to reduce potential for damage during installation.
   6. Field-Applied Insulation:
      a. Components that are not factory insulated shall be field insulated to comply with requirements indicated.
      b. Manufacturer shall be responsible for chiller insulation whether factory or field installed to ensure that manufacturer is the single point of responsibility for chillers.
      c. Manufacturer’s factory-authorized service representative shall instruct and supervise installation of field-applied insulation.
      d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

2.9 **ELECTRICAL**

A. Factory installed and wired, and functionally tested at factory before shipment.
B. Factory-installed and wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.

C. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.

D. Wiring shall be numbered and color-coded to match wiring diagram.

E. Factory wiring shall be located outside of an enclosure in a metal raceway. Terminal connections shall be made with not more than a 24-inch length of liquidtight or flexible metallic conduit.

F. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system, but not less than 65,000 A.

G. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
   1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
   2. NEMA KS 1, heavy-duty, nonfusible switch.
   3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

H. Each motor shall have overcurrent protection.

I. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.

J. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.

K. Power Factor Correction: Capacitors to correct power factor to 0.95 at full load.

L. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

M. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.

N. Service Receptacle:
   1. Unit-mounted, 120-V GFI duplex receptacle.
   2. Power receptacle from chiller internal electrical power wiring.

O. Indicate the following for water chiller electrical power supply:
   1. Current, phase to phase, for all three phases.
   2. Voltage, phase to phase and phase to neutral for all three phases.
   3. Three-phase real power (kilowatts).
   4. Three-phase reactive power (kilovolt amperes reactive).
   5. Power factor.
   6. Running log of total power versus time (kilowatt hours).
   7. Fault log, with time and date of each.

2.10 CONTROLS

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

C. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.

D. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, digital display. Display the following:
1. Date and time.
2. Operating or alarm status.
3. Operating hours.
4. Outside-air temperature if required for chilled-water reset.
5. Temperature and pressure of operating set points.
6. Chilled-water entering and leaving temperatures.
7. Refrigerant pressures in evaporator and condenser.
8. Saturation temperature in evaporator and condenser.
9. No cooling load condition.
10. Elapsed time meter (compressor run status).
11. Pump status.
12. Antirecycling timer status.
15. Number of compressor starts.
16. Alarm history with retention of operational data before unit shutdown.
17. Superheat.

E. Control Functions:
1. Manual or automatic startup and shutdown time schedule.
2. Capacity control based on evaporator leaving-fluid temperature.
3. Capacity control compensated by rate of change of evaporator entering-fluid temperature.
4. Chilled-water entering and leaving temperatures, control set points, and motor load limit.
   Chilled-water leaving temperature shall be reset based on return-water temperature.
5. Current limit and demand limit.
6. Condenser-water temperature.
7. External water chiller emergency stop.
8. Antirecycling timer.

F. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
1. Low evaporator pressure or high condenser pressure.
2. Low chilled-water temperature.
3. Refrigerant high pressure.
4. High or low oil pressure.
5. High oil temperature.
7. Loss of condenser-water flow.
8. Control device failure.

G. BAS / DDC System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.
1. Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through DDC system for HVAC.

H. Factory-installed wiring outside of enclosures shall be in NFPA 70-complaint raceway. Make terminal connections with liquidtight or flexible metallic conduit.

2.11 CAPACITIES AND CHARACTERISTICS
A. Refer to drawing schedule.
B. Low Ambient Operation: Chiller designed for operation to 0 deg F.
2.12 ADDITIONAL ACCESSORIES
   A. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.
   B. Factory-furnished spring isolators for field installation.

2.13 SOURCE QUALITY CONTROL
   A. Perform functional test of water chillers before shipping.
   B. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
   C. For water chillers located outdoors, rate sound power level according to AHRI 370 procedure.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
      1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WATER CHILLER INSTALLATION
   A. Coordinate sizes and locations of bases with actual equipment provided. Cast anchor-bolt inserts into concrete bases.
   B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.
   C. Install water chillers on support structure indicated.
   D. Equipment Mounting:
      1. Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
      2. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC."
   E. Maintain manufacturer’s recommended clearances for service and maintenance.
   F. Maintain clearances required by governing code.
   G. Chiller manufacturer’s factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
   H. Install separate devices furnished by manufacturer and not factory installed.
      1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.3 PIPING CONNECTIONS
   A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Comply with requirements in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties. It is the responsibility of the chiller manufacturer to confirm suitability of refrigerant piping for remote evaporator. In addition to requirements noted elsewhere, the Division 23 contractor shall provide and install all necessary and manufacturer recommended piping, valves and fittings for the project application, pipe routing and remote evaporator elevation.

C. Where installing piping adjacent to chillers, allow space for service and maintenance.

D. Evaporator Fluid Connections:
   1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
   2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, and drain connection with valve.
   3. Make connections to water chiller with a flange or mechanical coupling.

E. Connect each drain connection with a drain valve, full size of drain connection.

F. Connect each chiller vent connection with a manual vent, full size of vent connection.

3.4 ELECTRICAL POWER CONNECTIONS
A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS
A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and BAS/DDC system for remote monitoring and control of chillers. Comply with requirements in Section 230900.

D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.

3.6 STARTUP SERVICE
A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
   2. Verify that pumps are installed and functional.
   3. Verify that thermometers and gages are installed.
   4. Operate water chiller for run-in period.
   5. Check bearing lubrication and oil levels.
   6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
   7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

E. Prepare a written startup report that records results of tests and inspections.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers. Video record the training sessions and provide electronic copy to Owner.
   1. Instructor shall be factory trained and certified.
   2. Provide not less than eight hours of training.
   3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
   4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
   5. Obtain Owner sign-off that training is complete.
   6. Owner training shall be held at Project site.

END OF SECTION
SECTION 237316
AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes constant and variable air volume, factory-fabricated, double-wall, air-handling units for indoor installations.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 03 Sections for cast-in place concrete bases and curbs.
   2. Division 23 Section "Common Motor Requirements for HVAC Equipment"
   3. Division 23 Section "Variable Speed Motor Controllers"
   4. Division 23 Section "Vibration Controls for HVAC Piping and Equipment"
   5. Division 23 Section "Duct Accessories"
   6. Division 23 Section "Particulate Air Filtration"
   7. Division 23 Section "Instrumentation and Controls for HVAC"
   8. Division 23 Section "Sequence of Operation for HVAC Controls"
   9. Division 26 Sections for power supply wiring, including disconnect switches, motor starters, and required electrical devices. Division 23 furnishes variable speed drives.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

B. Product data for each air-handling unit component indicated, including the following:
   1. AMCA certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound power ratings.
   3. Certified sound power ratings with calculations for each supply air, return air, relief or exhaust air, and outside air opening for each air handling unit.
   4. Certified unit casing radiated sound power with calculations for each air handling unit.
   5. Vibration isolation data.
   6. ARI certified coil performance ratings with system operating conditions indicated.
   7. Motor ratings and electrical characteristics plus motor and fan accessories.
   8. Variable speed drive data.
   9. Cabinet and frame materials, gages, and finishes.
   10. Air filter holding frame materials and assembly details.

C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field-assembly, components, and location and size of each field connection.
   1. Show internal air handling unit components. Indicate dimensions between individual components and air handling unit walls, floors and ceilings.
   2. Show support locations, type of support, and weight on each support.
   3. Vibration Isolation Base Details (Unit and Fans): Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

D. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.
E. Product certificates signed by manufacturers of air-handling units certifying that their products comply with specified requirements. Where there are differences they shall be specifically identified.

F. Field installation and assembly instructions for air-handling unit cabinets and internal components.

G. Field test reports indicating and interpreting test results relative to compliance with specified requirements specified in Part 3 of this Section.

H. Maintenance data for air-handling units to include in Operating and Maintenance Manual specified in Division 01 Sections.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain outdoor air-handling units through one source from a single manufacturer.

B. NFPA Compliance: Air-handling units and components will be designed, fabricated, and installed in compliance with NFPA Standard 90A “Standard for the Installation of Air Conditioning and Ventilating Systems.”

C. Comply with NFPA 70 for components and installation.

D. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled. The Terms “Listed and Labeled” will be defined in the National Electric Code, Article 100.

E. Project Altitude: Base fan performance ratings on sea level.

F. Operating Limits: Classify according to AMCA 99.

G. Fan-Section Source Quality Control:
   2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, “Laboratory Methods of Testing Fans for Rating.”
   3. Fan Balancing: Fans will be factory balanced and AMCA Certified to meet ANSI S2.19 grade G6.3 requirements. Filter-in vibration measurements will not exceed 0.15 in/second peak at the fan RPM.

H. Sound:
   1. Applicable Standards
      a. All sound power level measurements shall be made in complete accordance with the latest version of ARI Standard 260, Sound Rating of Ducted Air Moving and Conditioning Equipment. Equivalent test procedures may be substituted for the above procedures if approved in advance by the Architect and Acoustical Consultant. The sound power level of the air handling unit’s supply air, return air, relief or exhaust air, and outside air openings and case-radiated noise shall not exceed the values list in the Air Handling Unit Schedule below when operating at the maximum design airflow and static pressure conditions.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver air-handling units as a single factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Lift and support units with the manufacturer's designated lifting or supporting points.

C. Disassemble and reassemble units only when required for movement into the final location following manufacturer's written instructions.
D. Protect units from physical damage, water and moisture penetration, corrosion, and general construction dirt and debris. Use extraordinary means to assure units are turned over to the Owner in like new condition, clean and undamaged.

E. Units will not be used for tool, material, and equipment storage; or any other purpose during construction.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements. Verify Clearances.

B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and fans have been commissioned.

1.7 COORDINATION

A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete reinforcement and formwork requirements are specified in Division 3 Sections.

B. Coordinate layout and installation of air-handling units with piping, ducts, conduit; the installation will allow access doors to swing a minimum of 90-degrees. Provide an unobstructed entrance path for each access door.

C. Coordinate size and location of factory and field installed control dampers.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: Two sets for each belt-driven fan size.

2. Gaskets: One set(s) for each access door.

3. Provide one additional complete set of filters for each filter or filter bank.

4. Provide one additional variable frequency drive per each size of variable frequency drive provided.

5. Provide one additional motor per each size of motor provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Structural Performance: Casing panels shall be self-supporting and capable of withstanding positive/negative 8-inch wg of internal static pressure, without exceeding a midpoint deflection of 0.0042 inch/inch of panel span.

F. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at [plus or minus 8 inch wg.

2.2 CAPACITIES AND CHARACTERISTICS

A. Refer to the equipment schedules for capacities and characteristics of each component.
2.3 AIR-HANDLING UNIT MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Buffalo Air Handling
   2. Carrier Corporation
   3. Daikin Applied
   4. Trane
   5. Ventrol Air Handling Systems Incorporated
   6. Climate Craft
   7. York (JCI)
   8. Hunt Air / Temtrol

2.4 UNIT CASINGS
A. The air-handling unit shall be specifically designed for use in an indoor or outdoor application, as specified and indicated on drawings.

B. The construction of the air handling unit shall consist of a complete structural frame with removable panels. Casing shall be supported in such a manner so that maximum allowable air leakage shall not exceed 1% and panel deflection shall not exceed a L/240 ratio when subjected to +/- 8-in. w.g. static pressure. All panels shall be completely gasketed prior to shipment and shall be completely removable for unit access and removal of components. Removal of any or all panels shall not affect the structural integrity of the unit.

C. The air-handling unit shall be provided with a full perimeter base rail channel.
   1. The base rail channel shall be formed of 16-gage minimum galvanized steel.
   2. The base rail channel shall have a minimum height of 8" to insure adequate clearance for drain pipe trapping.
   3. The base rail channel shall support all major components.
   4. Perimeter structural steel lifting lugs shall be provided to accommodate overhead lifting.

D. The air-handling unit shall be supplied with double wall panels for walls, roof, and floor constructed of G90 mill galvanized sheet steel.

E. Outdoor air handling unit(s) shall be provided with a full-perimeter, insulated roof curb. Roof curb shall ship loose for field installation prior to unit placement.
   1. Roof curb shall be a prefabricated galvanized steel-mounting curb.
   2. Roof curb application shall provide for continuous insulation between unit panels and roof curb.
   3. The roof curb shall have 1.5-inch, 3 pound per cubic foot density fiberglass insulation.
   4. Roof curb shall be a perimeter type providing complete perimeter support of the air-handling unit.
   5. Roof curb shall be flat or sloped to accommodate the roof pitch.
   6. The curb shall be a minimum 18 gage and a minimum of 14 inches high.
   7. Gasketing shall be provided for field mounting between the unit base and the roof curb.
   8. The curb shall include a 1" x 4" wood nailer.

F. Outdoor air handling unit(s) shall be provided with an external, double wall construction, insulated vestibule for enclosed service and to fully contain field piping and valves. Vestibule must provide sufficient space for services, access and coil connections and piping to be installed without interference. Vestibule enclosures of adjacent segments shall be combined to be a continuous open vestibule.
   1. Refer to drawings for vestibule depth, with an internal clearance of 2" less than nominal dimension.
   2. Vestibule wall and floor construction shall be the same as that of the unit.

G. The air handling unit casing shall be constructed of 2" thick double wall roof panels, floor panels, and wall panels having exterior construction of 16 gage G90 galvanized steel. The interior lining shall be a solid lining of minimum 20 gage or .080" thick aluminum perforated lining in specific fan segments. Exterior casing screws shall be zinc chromate coated.
H. Floor panels shall be double wall construction, designed to provide at most L/240 deflection based on 300 lb. concentrated load at mid-span. The interior liner of the floor panels shall be a solid lining of minimum 20 gage galvanized. An additional 0.125” aluminum diamond tread plate liner shall be provided as a walk-on surface in unit access areas.

I. The outdoor air-handling unit shall be supplied with a double-sloped roof to promote drainage of precipitation and prevent standing water.
   1. Roof construction design shall accommodate a minimum snow-load of 30 lb/ft².
   2. The roof shall have a minimum pitch of 1/4” per foot.
   3. The roof shall overhang all side and end panels to prevent precipitation drainage from streaming down the unit wall panels.
   4. Outdoor units supplied with flat roofs shall not be acceptable.

J. The air-handling unit shall be completely insulated throughout all panels and structural frame members with spray injected foam to thoroughly insulate and seal the air unit structure. Openings in structural channels shall be covered. If structural channels are not internally insulated, then structural channels must be wrapped with an armaflex type insulation to maintain unit thermal performance and prevent sweating. Any portion of the unit that is not insulated (gaps) or has less than 2” of insulation shall be the responsibility of the contractor to modify.
   1. Insulation shall be a full 2” throughout the entire unit.
   2. Units with less than 2” of insulation in any part of the walls, floor, or roof shall not be acceptable.
   3. Insulation application shall conform to NFPA 90A requirements.
   4. Panels shall have a minimum thermal conductivity R of 12.5 (Hr·Ft²·°F/BTU).
   5. For outdoor units, all vestibules, coil header panels and return bend panels shall be fully insulated.
   6. Panels with perforated panel liner shall utilize a triple-wall construction, joining a matte-faced fiberglass insulated panel with a foam insulated panel to achieve both superior thermal performance and sound attenuation.
   7. All drain pans shall have double-wall construction and be insulated with spray injected foam. Fiberglass insulation is not acceptable.

K. Double wall access doors shall be provided on sections as detailed. Doors shall be of the same material type as the wall panels. A bulb-type gasket shall be provided around the entire door perimeter. Industrial style stainless steel hinges shall permit a complete 180 degree door swing. All doors shall open against positive pressure.
   1. Access door must be of the same material type as exterior/interior casing.
   2. Access door latches shall utilize a roller cam latching mechanism to insure maximum sealing.
   3. Access doors shall be provided with a single door handle linked to multiple latching points. Stacked indoor units shall insure door handles are positioned at the lowest possible point of the top tier segments for convenient access.
   4. Doors serving outdoor air unit vestibule shall be provided with inside operable door latches.
   5. Outdoor unit vestibule access doors shall be provided with a key-lock. All access doors shall be operated by the same key.

L. Viewing windows shall be provided as shown on details. All windows shall be double-pane tempered glass.

M. Provide auxiliary drain pans in segments as indicated on the schedule.
   1. The auxiliary pans shall be double sloped, positive draining with stainless steel liner and double wall construction with drain connection of like material, draining to one side of the unit.
   2. Drain connection shall be welded to the drain pan. If threaded screw-type joint is used, all joints must be easily accessible for inspection and service.

N. Outdoor air handling units shall be provided with a rain-hood and bird screen assembly for protection of the outside and exhaust air dampers from the elements. The outside air hood shall have a moisture eliminator. Configure the exhaust air or outdoor air connections per details and provide necessary air-stream separation when routed through unit service and pipe vestibule.
O. Convenience Outlets: One 20-A duplex GFCI receptacle per air handling unit with junction box located on outside casing wall.
   a. Locations: Fan section.

2.5 FAN, DRIVE, AND MOTOR SECTION

A. Fans shall be Class I, II, and III, as scheduled and selected to provide scheduled performance.

B. Fan segments shall be equipped with double width double inlet (DWDI) housed fans or [single width single inlet (SWSI) plenum fans as scheduled. Double width double inlet (DWDI) fans shall be industrial grade, having airfoil or forward curved blades as scheduled. All single width single inlet fans (SWSI) fans shall have airfoil (AF) blades. Flat plate blades shall not be acceptable.

C. All airfoil fans shall bear the AMCA Seal. Airfoil fan performance shall be based on tests made in accordance with AMCA standards 210 and comply with the requirements of the AMCA certified ratings program for air and sound. In addition, all airfoil wheels shall comply with AMCA standard 99-2408-69 and 99-2401-82.

D. SWSI fans shall be provided with inlet screens, fan screens and belt guards. DWDI fans shall be provided with inlet screens as specified.

E. Industrial grade DWDI airfoil fans shall be provided with an optional access door in the fan scroll.

F. Fans shall have polished steel shafts sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class. Close tolerances shall be maintained where the shaft makes contact with the bearing. Shaft shall be factory coated after assembly with an anti-corrosion coating.

G. After the pre-balanced fan is installed on the fan skid and isolator rails, the entire fan skid shall be run-balanced at the specified speed to insure smooth and trouble-free operation. The run balance shall include filter-in and filter-out balancing in all three (3) planes, on both sides of the fan assembly at the bearings.
   1. Filter-in measurements shall be taken in the horizontal and vertical planes on the drive and opposite-drive sides of the fan shaft.
   2. Filter-out measurements shall be taken in the horizontal, vertical and axial planes on the drive and opposite-drive side of the fan shaft.

H. The fan motor and fan-assembly shall be internally mounted. The fan motor and fan-assembly shall be mounted on a common base to allow consistent belt tension with no relative motion between the fan and motor shafts. The common base shall be isolated on a full width isolator support channel using 1” springs.
   1. Fan motor and drive shall be contained within an OSHA-compliant belt guard.
   2. The fan motor shall be on an adjustable base.
   3. The fan discharge shall be connected to the cabinet through a canvas flexible connection to insure vibration-free operation.
   4. Thrust restraints shall be provided as specified to mitigate fan assembly vibration in the horizontal plane.
   5. Fan segments shall be equipped with an access door.
   6. Fan sections shall be equipped with safety screens covering bottom inlets and discharge openings, sufficient to hold 300 lb. service person with minimal deflection.
   7. Fan assemblies shall be balanced for inverter duty operation.
   8. The fan will be balanced over the entire range of fan operation (30% to 100% of RPM).

I. Fan Bearings
   1. Fan bearings shall be designed for an average life (L10) of at least 200,000.
   2. All re-greaseable bearings shall be factory lubricated and equipped with standard hydraulic grease fittings and lube lines.
J. Fan Arrays: Steel or aluminum frame with inlet cone and structural framing around each fan built into an array of multiple fans. Provide backdraft dampers with integral counterbalance at each fan to prevent short circuiting of flow if one fan is not operating.

K. Fan airflow monitoring: Each fan shall be provided with a factory installed airflow measuring device – piezo ring or approved equivalent. Sensor accuracy shall be +/-3%. Performance shall have been verified in an AMCA registered air chamber. Factory installed assembly shall include flow sensors for field connection to a transducer provided by others.

L. Fans or unit shall be provided with appropriate silencers, acoustic baffles, or sound traps rated for the application to meet sound attenuation values indicated on the schedule.

M. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. NEMA Premium Efficient motors as defined in NEMA MG 1.
   2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   4. Mount unit-mounted disconnect switches on exterior of unit.

N. Variable-Frequency Motor Controller: Comply with Specification "Variable-Frequency Motor Controllers."

2.6 COIL SECTION

A. Coil segment length shall be optimized to contain selected coil(s), spacer(s), and optional access doors. Coils shall be selected to maximize unit tunnel area using single or stacked coil arrangements as needed to satisfy required coil face areas.
   1. Coil segment design and coil selection shall not require a drain pan in any downstream section to contain the coil condensate.
   2. All cooling and/or heating coils shall be furnished to meet the performance requirements set forth in the schedule.
   3. All water coils shall have performance certified in accordance with ARI Standard 410 for coil capacity and pressure drop.
   4. Multiple coils in a single coil segment shall be separated by galvanized steel or stainless steel coil spacers in chilled water coils. Coil spacers should accommodate side-access via a removal side-plate.
   5. Coil segment side panels shall be removable to allow for removal and replacement of coils, without affecting the structural integrity of the unit.
   6. Upstream and downstream segment door clearances shall accommodate a minimum 2-inches of field installed external piping insulation.
   7. Coil segment shall accommodate full-face height or reduced face height coils.

B. Cooling Coil Segment shall be provided with a full-width, multi-sloped (IAQ) stainless-steel drain pan that extends downstream a minimum 6” beyond the last coil in the section to provide drain pan access for cleaning and inspection.

C. Drain pan design and application shall comply fully with the stated intent of ASHRAE 62-2001.

D. Drain pans shall be sloped in a minimum of 2 planes; cross break interior pans and pitch toward drain connections to ensure complete condensate drainage. Units with cooling coils shall have drain pans under complete cooling coil section. A minimum of 1” clearance shall be provided from the bottom of the coil casing to the drain pan so that the drain pan can be visually inspected and physically cleaned, including underneath coil, without removal of the coil. All drain pan connections will be to one side of the unit to enable proper trapping. Drain pans that do not comply with these maintenance requirements will be the responsibility of the contractor to field modify.
E. The drain pan shall be of double wall construction with stainless steel liner and shall be insulated with spray-injected foam to completely seal the drain pan assembly. Fiber- glass insulation is not acceptable.

F. Drain pan shall be provided with a minimum 1-1/4" MPT condensate connection positioned beneath the lowest point of the drain pan. Drain connection shall be welded to the drain pan and shall match the drain pan liner material type. If threaded screw-type joint is used, all joints must be easily accessible for inspection and service.

G. All coils shall be slide out, "shipping" type, mounted on tracks, and easily removable from the air handling unit by removing only one exterior panel. Coils that require additional disassembly of the unit or replacement of the entire coil section (e.g. "unit" type coils) for coil removal are unacceptable.

H. Coils shall be supported by galvanized or stainless steel for chilled water coil support members, constructed of channeled members, allowing uninhibited access for inspection and safe cleaning.

I. All vertical coil supporting members (bulkheads) and blockoffs shall be constructed of galvanized steel or stainless steel for chilled water and shall entirely seal off the coil, preventing air bypass.

J. Coil grommets shall be provided on all coils to completely seal the area between the coil connection and the unit casing.

K. Drainable Water coils shall be designed to operate at 250 psig design working pressure and up to 300° F and shall be tested with 325 psig compressed air under water. Circuiting shall provide free and complete draining and venting when installed in the unit. All vent and drain connections shall be extended to the outside of the unit casing.

L. The primary surface shall be 5/8" O.D. or 1/2" O.D. copper tube, staggered in direction of airflow. Tubes shall be mandrel expanded to form fin bond and provide burnished, work-hardened interior surface. The tubes shall have a minimum tube wall thickness of 0.020". Specified thickness shall be maintained throughout the tube including brazed U-bends.

M. Extended surface shall consist of die-formed, continuous, aluminum enhanced performance fins. The fins shall have fully drawn collars to accurately space fins, and to form a protective sheath for the primary surface.

N. Coils with finned height greater than 48 inches shall have an intermediate drain pan extending the entire finned length of the coil. Cooling coils in excess of 48 inches in height shall not be acceptable unless provided with an intermediate drain pan. The intermediate pans shall have copper down spouts to guide condensate to the main drain pan.

O. Coil casing shall be constructed of 16-gauge galvanized steel or stainless steel for chilled water. Tube sheets on each end shall have drawn collars to support tubes. A single intermediate coil support shall be provided on coils with a finned length of more than 62 inches, two (2) intermediate supports above 100 inches in length, and three (3) intermediate supports on coils with a finned length of more than 141 inches. Casing channels shall be free-draining, without depressions to collect moisture and contaminants. Casing channels shall not block fin area.

P. Headers shall be of heavy seamless copper tubing, silver-brazed to tubes. Connections shall be of steel, with male pipe threads, silver-brazed to the headers. A 1/4" FPT, plugged vent or drain tap shall be provided on each connection. All vent and drain connections shall be extended to the outside of the unit casing.

Q. Circuiting shall be to provide free draining and venting, through one vent and one drain on each coil, when installed with casing level. Coils shall be circuited, and have connections arranged, for counter- flow of air and water with supply on bottom and return on top of coil headers. Coil circuiting shall provide for design water velocity in tubes without exceeding total water pressure drops in schedule.

R. Coils using turbulators are unacceptable.

S. Refer to coil schedules for additional coil requirements.
2.7 AIR FILTRATION SECTION
   A. General Requirements for Air Filtration Section:
      1. Comply with NFPA 90A.
      2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
      3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
      4. A magnehelic differential pressure gauge shall be factory installed and flush mounted to measure the pressure drop across the filter bank.
      5. Refer to Division 23 Section “Particulate Air Filtration” and air filter schedules for additional requirements.

2.8 DAMPERS
   A. All dampers will be of ultra-low leak design having airfoil blades. The damper blades shall be provided with extruded vinyl edge seals and flexible metal compressible jamb seals.
   B. General Requirements for Dampers: Leakage rate, according to AMCA 500, “Laboratory Methods for Testing Dampers for Rating,” 4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa).
   C. Damper Operators: Provided in Section 230900.
   D. Outdoor- and Return-Air Dampers shall be parallel blade dampers arranged to promote mixing.

2.9 SOURCE QUALITY CONTROL
   A. AHRI 430 Certification: Air-handling units and their components shall be factory tested according to AHRI 430 and shall be listed and labeled by AHRI.
   B. AMCA 301 or AHRI 260: Air-handling unit fan sound ratings shall comply with AMCA 301, “Methods for Calculating Fan Sound Ratings from Laboratory Test Data,” or AHRI 260, “Sound Rating of Ducted Air Moving and Conditioning Equipment.”
   D. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, “Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.”
   E. Water Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.

2.10 ELECTRICAL CONNECTION
   A. Refer also to Mechanical Electrical Coordination schedule for electrical connection requirements.
   B. Units shall be a single point power connection with the exception of AHU-2 and with an external unit disconnect and separate circuit for unit lights and convenience receptacles. Provide switch with indicator light to power air handling unit lights. Indicator light shall be on whenever unit lights are off.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Equipment Mounting:
   1. Install air-handling units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Comply with requirements for vibration isolation devices specified in Section "Vibration Controls for HVAC."

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

### 3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

### 3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

E. Refer also to Electrical Mechanical Coordination schedule for electrical connection requirements.
3.5 CONTROL CONNECTIONS
A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
   2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
D. Prepare test and inspection reports.

3.7 STARTUP SERVICE
A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify that shipping, blocking, and bracing are removed.
   3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
   4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
   5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
   6. Verify that zone dampers fully open and close for each zone.
   7. Verify that face-and-bypass dampers provide full face flow.
   8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
   10. Verify that proper thermal-overload protection is installed for electric coils.
   11. Install new, clean filters.
   12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
B. Starting procedures for air-handling units include the following:
   1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
   2. Measure and record motor electrical values for voltage and amperage.
   3. Manually operate dampers from fully closed to fully open position and record fan performance.
C. Startup report: The startup report shall indicate that the listed startup tasks have been performed and list the results.

3.8 ADJUSTING
A. Adjust damper linkages for proper damper operation.
B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.9 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.
   1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
   2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Closeout Procedures".

B. Schedule training with at least 14 days' advance notice.

END OF SECTION
SECTION 238123
COMPUTER-ROOM AIR-CONDITIONING UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Floor-mounted computer-room air conditioners

1.3 DEFINITION
A. BAS: Building automation system.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings: For computer-room air conditioners. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, are using input from Installers of the items involved.
B. Field quality-control reports.
C. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan Belts: One for each belt-driven fan.
   2. Filters: One set(s) of filters for each unit.

1.8 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

D. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

1.9 COORDINATION

A. Coordinate layout and installation of computer-room air conditioners and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate installation of computer-room air conditioners with computer-room access flooring Installer.

C. Coordinate sizes and locations of concrete bases with actual equipment provided.

D. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

2. Warranty Period for Humidifiers: Manufacturer's standard, but not less than three years from date of Substantial Completion.

3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Compu-Aire, Incorporated (www.compu-aire.com)

2. Data Aire Incorporated (www.dataaire.com)

3. Liebert Corporation (www.emersonnetworkpower.com)

4. Stulz-ATS. (www.stulz-ats.com)

B. Description: Packaged, factory assembled, prewired, and prepped; consisting of cabinet, fans, filters, and controls.

C. Cabinet and Frame: Welded steel, braced for rigidity, and supporting compressors and other mechanical equipment and fittings.


2. Insulation: Thermally and acoustically insulate cabinet interior with 1-inch- thick duct liner.

3. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

4. Finish of Exterior Surfaces: Baked-on, textured vinyl enamel; color as selected from manufacturer's standard colors.

5. Floor Stand: Welded tubular steel, with adjustable legs and vibration isolation pads.

D. Supply-Air Fan(s):
1. Electronically commutated plug-type, direct-drive fan with backward curved blades and ECM motor.

E. Refrigeration System:
1. Compressors: Digital scroll with variable capacity operation from 20-100%; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
   a. Provide factory compressor sound jacket with closed cell polymeric jacket.
2. Refrigeration Circuits: Two; each with hot-gas mufflers, thermal-expansion valve with external equalizer, liquid-line solenoid valve, liquid-line filter-dryer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
3. Refrigerant: R-410A.
4. Refrigerant Evaporator Coil: Alternate-row or split-face-circuit, direct-expansion coil of seamless copper tubes expanded into aluminum fins.
   a. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral dual-level float switch, pump-motor assembly, and condensate reservoir.
5. Remote Air-Cooled Refrigerant Condenser: Corrosion-resistant cabinet, copper-tube aluminum-fin coils arranged for two circuits, multiple direct-drive propeller fans with permanently lubricated ball bearings, and single-phase motors with internal overload protection and integral electric control panel and disconnect switch.
6. Low Ambient Kit: Permits operation down to 0 degrees F.


G. Extended-Surface, Disposable, Panel Filter: Pleated, lofted, nonwoven, reinforced cotton fabric; supported and bonded to welded-wire grid; enclosed in cardboard frame with 2-inch- thick, disposable, glass-fiber pre-filter.

H. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

I. SSCR: 65,000 amp short circuit rating.

J. Microprocessor-Control System: Continuously monitors operation of process cooling system; continuously displays room temperature and room relative humidity; sounds alarm on system malfunction and simultaneously displays problem. If more than one malfunction occurs, system displays fault in sequence with room temperature and continues to display fault when malfunction is cleared until system is reset.
1. Malfunctions:
   a. Power loss.
   b. Loss of airflow.
   c. Clogged air filter.
   d. High room temperature.
   e. Low room temperature.
   f. High humidity.
   g. Low humidity.
   h. Smoke/fire.
   i. Water under floor.
   j. Supply fan overload.
   k. Compressor No. 1 - Overload.
   l. Compressor No. 1 - Low Pressure.
   m. Compressor No. 1 - High Pressure.
   n. Compressor No. 2 - Overload.
   o. Compressor No. 2 - Low Pressure.
   p. Compressor No. 2 - High Pressure.
2. Digital Display:
   a. Control power on.
   b. Dehumidifying.
   c. Compressor No. 1 - Operating.
   d. Compressor No. 2 - Operating.
   e. Heat operating.
   f. Economy cooling.

3. Push buttons shall stop and start process cooling system, silence audible alarm, test indicators, and display room's relative humidity.

4. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display unit status and alarms.
   a. ASHRAE 135 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.

K. Additional accessories:
   1. High temperature sensor
   2. Remote temperature and humidity sensors
   3. Smoke sensor

2.2 FAN MOTORS
A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven loads will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.3 CAPACITIES AND CHARACTERISTICS
A. Refer to equipment schedules for capacities and characteristics.

2.4 ELECTRICAL CONNECTION
A. Refer also to Electrical Coordination schedule for electrical connection requirements. Electrical connection requirements include, but are not limited to, variable speed drives, disconnects, voltage, controls/switching.

2.5 BUILDING AUTOMATION SYSTEM INTERFACE
A. Refer also to Sequence of Operation for necessary control and interface requirements.

PART 3 - EXECUTION
3.1 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.
C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION
A. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances.
B. Computer-Room Air-Conditioner Mounting: Install using elastomeric pads or mounts. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
C. Air-Cooled Refrigerant Condenser Mounting: Install using elastomeric pads or mounts. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 CONNECTIONS
A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to machine to allow service and maintenance.
C. Water and Drainage Connections: Comply with applicable requirements in Section 221116 "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.
D. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Provide shutoff valves and piping.

3.4 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
C. Tests and Inspections:
   1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
D. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports.
F. After startup service and performance test, change filters.

3.5 ADJUSTING
A. Adjust initial temperature set points.
B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION
SECTION 238126
VARIABLE REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes complete VRF HVAC system(s) including, but not limited to, delegated design and the following components to make a complete operating system(s) according to requirements indicated:
   1. Indoor, concealed, ceiling-mounted units for ducting.
   2. Indoor, exposed, wall-mounted units.
   3. Indoor, recessed, ceiling-mounted units.
   4. Indoor, suspended, ceiling-mounted units.
   5. Outdoor, air-source, heat-pump units.
   6. Outdoor, air-source heat recovery units.
   7. Heat recovery control units.
   8. System controls.
   10. System condensate drain piping.
   11. System refrigerant piping.
   12. Piping and tubing insulation.
   13. System control cable and raceways.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for HRCUs.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
   4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
   5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and HRCU control.
   6. Include description of control software features.
   7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
   8. Include refrigerant type and data sheets showing compliance with requirements indicated.
   9. Indicate location and type of service access.
B. Shop Drawings: For VRF HVAC systems.
   1. Include plans, elevations, sections, and mounting / attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
5. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittals:
1. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.
2. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.
3. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural floors, roofs and associated members to which equipment, piping, ductwork, cables, and conduit will be attached.
   3. Size and location of initial access modules for acoustical tile.
   4. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
   5. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.
   6. Items penetrating finished ceiling including the following:
      a. Luminaires.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Service access panels.

B. Qualification Data:
   1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
      a. Retain copies of Installer certificates on-site and make available on request.
   2. For VRF HVAC system manufacturer.
   3. For VRF HVAC system provider.

C. Product Test Reports: Where tests are required, for each product, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranties: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
2. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least five completed projects.
4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:
   a. Product research and development.
   b. Product and application engineering.
   c. Product manufacturing, testing, and quality control.
   d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
   e. Owner training.

B. Factory- Authorized Service Representative Qualifications:
1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
2. In-place facility located within 100 miles of Project.
3. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.
4. Demonstrated past experience on five projects of similar complexity, scope, and value.
   a. Each person assigned to Project shall have demonstrated past experience.
5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
6. Service and maintenance staff assigned to support Project during warranty period.
7. Product parts inventory to support ongoing system operation for a period of not less than 20 years after Substantial Completion.
8. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.
1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience.
   a. Demonstrated past experience with products being installed for period within three consecutive years before time of bid.
   b. Demonstrated past experience on five projects of similar complexity, scope, and value.
5. Installers shall have staffing resources of competent, trained, and experienced full-time employees that are assigned to execute work according to schedule.

D. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.
1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer’s written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
   1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
   2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

1.8 WARRANTY

A. Manufacturer’s Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures.
      b. Faulty operation.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

   2. Warranty Period:
      a. For Compressor: Seven year(s) from date of Substantial Completion.
      b. For Parts, Including Controls: Five year(s) from date of Substantial Completion.
      c. For Labor: Five year(s) from date of Substantial Completion.

2.1 PART 2 - PRODUCTS MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Daikin AC (America) Inc.
   2. LG Electronics
   3. Mitsubishi Electric & Electronics USA, Inc
   4. Samsung HVAC

B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:
   1. Indoor and outdoor units, including accessories.
   2. Controls and software.
   3. HRCUs.
   4. Refrigerant isolation valves.
   5. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, HRCUs, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.
   1. Two-pipe or three-pipe system design.
   2. System(s) operation, heat pump or heat recovery as indicated on Drawings.
   3. Each system with one refrigerant circuit shared by all indoor units connected to system.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.

D. ASHRAE Compliance:
   1. ASHRAE 15: For safety code for mechanical refrigeration.
   2. ASHRAE 62.1: For indoor air quality.
   3. ASHRAE 135: For control network protocol with remote communication.
   4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional specialist, as defined in Section 014000 "Quality Requirements," to design complete and operational VRF HVAC system(s) complying with requirements indicated.

   1. Provide system refrigerant calculations.
      a. Refrigerant concentration limits shall be within allowable limits of ASHRAE 15 and governing codes.
      b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.

   2. System Refrigerant Piping and Tubing:
      a. Arrangement: Arrange piping to interconnect indoor units, HRCUs, and outdoor unit(s) in compliance with manufacturer requirements and requirements indicated.
      b. Routing: Conceal piping above ceilings and behind walls to maximum extent possible.
      c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated. Consider requirements to accommodate future change requirements.

   3. System Controls:
      a. Network arrangement.
      b. Network interface with other building systems.
      c. Product selection.
      d. Sizing.

B. Service Access:

   1. Provide and document service access requirements.
   2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
   3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
   4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.
   5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
   6. Comply with OSHA regulations.

C. System Design and Installation Requirements:

   1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
   2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.
D. System Adaptability to Future Changes: Arrange and size system refrigerant piping to accommodate future changes to system without having to resize and replace existing refrigerant piping as indicated on drawings.

E. Isolation of Equipment: Provide isolation valves to isolate each HRCU, indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.

F. System Turndown: Stable operation down to 15 percent of outdoor-unit capacity.

G. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.

H. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.

I. Capacities and Characteristics: As indicated on Drawings.

2.4 INDOOR, CONCEALED, CEILING-MOUNTED UNITS FOR DUCTING

A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:
   1. Material: Galvanized or painted steel.
   2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
   3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
   4. Mounting: Manufacturer-designed provisions for field installation.
   5. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:
   1. Coil Casing: Aluminum, galvanized, or stainless steel.
   2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
   3. Coil Tubes: Copper, of diameter and thickness required by performance.
   4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
   5. Unit Internal Tubing: Copper tubing with brazed joints.
   6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
   7. Field Piping Connections: Manufacturer's standard.
   8. Factory Charge: Dehydrated air or nitrogen.
   9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:
   1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
   2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
   3. Field Piping Connection: Non-ferrous material with threaded NPT.

E. Fan and Motor Assembly:
   1. Fan(s):
      a. Direct-drive arrangement.
      b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
      c. Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.
      d. Wheels statically and dynamically balanced.
   2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
4. **Speed Settings and Control:** Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of at least 50 percent.

5. **Vibration Control:** Integral isolation to dampen vibration transmission.

**F. Filter Assembly:**
1. **Access:** Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
2. **Efficiency:** ASHRAE 52.2, MERV 8.
3. **Media:**
   a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

**G. Unit Accessories:**
1. **Remote Room Temperature Sensor Kit:** Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

**H. Unit Controls:**
1. **Enclosure:** Metal, suitable for indoor locations.
2. **Factory-Installed Controller:** Configurable digital control.
3. **Factory-Installed Sensors:**
   a. Unit inlet air temperature.
   b. Coil entering refrigerant temperature.
   c. Coil leaving refrigerant temperature.
4. **Field-Customizable I/O Capability:**
5. **Features and Functions:**
   a. Self-diagnostics.
   b. Time delay.
   c. Auto-restart.
   d. External static pressure control.
   e. Auto operation mode.
   f. Manual operation mode.
   g. Filter service notification.
   h. Power consumption display.
   i. Drain assembly high water level safety shutdown and notification.
   j. Run test switch.
6. **Communication:** Network communication with other indoor and outdoor units.
7. **Cable and Wiring:** Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. **Field Connection:** Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

**I. Unit Electrical:**
1. **Enclosure:** Metal, suitable for indoor locations.
2. **Field Connection:** Single point connection to power unit and integral controls.
3. **Disconnecting Means:** Factory-mounted circuit breaker or switch.
4. **Control Transformer:** Manufacturer's standard. Coordinate requirements with field power supply.
5. **Wiring:** Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. **Raceways:** Enclose line voltage wiring in metal raceways.
2.5 INDOOR, EXPOSED, WALL-MOUNTED UNITS

A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

B. Cabinet:
   1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
   2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
   3. Mounting: Manufacturer-designed provisions for field installation.
   4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:
   1. Coil Casing: Aluminum, galvanized, or stainless steel.
   2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
   3. Coil Tubes: Copper, of diameter and thickness required by performance.
   4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
   5. Unit Internal Tubing: Copper tubing with brazed joints.
   6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
   7. Field Piping Connections: Manufacturer's standard.
   8. Factory Charge: Dehydrated air or nitrogen.
   9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:
   1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
      a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.
   3. Field Piping Connection: Non-ferrous material with threaded NPT.

E. Fan and Motor Assembly:
   1. Fan(s):
      a. Direct-drive arrangement.
      b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
      c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
      d. Wheels statically and dynamically balanced.
   2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
   4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
   5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:
   1. Access: Front, to accommodate filter replacement without the need for tools.
   2. Efficiency: MERV 8.

G. Grille Assembly: Manufacturer's standard discharge grille with field-adjustable air pattern mounted in top or front face of unit cabinet.

H. Unit Accessories:
   1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.

I. Unit Controls:
   1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
   2. Factory-Installed Controller: Configurable digital control.
   3. Factory-Installed Sensors: Unit inlet air temperature, Coil entering refrigerant temperature, Coil leaving refrigerant temperature.
   4. Field-Customizable I/O Capability:
   5. Features and Functions:
      a. Self-diagnostics.
      b. Time delay.
      c. Auto-restart.
      d. External static pressure control.
      e. Auto operation mode.
      f. Manual operation mode.
      g. Filter service notification.
      h. Power consumption display.
      i. Drain assembly high water level safety shutdown and notification.
      j. Run test switch.
   6. Communication: Network communication with other indoor units and outdoor unit(s).
   7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
   8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

J. Unit Electrical:
   1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
   2. Field Connection: Single point connection to power entire unit and integral controls.
   3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
   4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
   5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
   6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

2.6 INDOOR, RECESSED, CEILING-MOUNTED UNITS

A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:
   1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
   2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
   3. Mounting: Manufacturer-designed provisions for field installation.
   4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:
   1. Coil Casing: Aluminum, galvanized, or stainless steel.
   2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Internal Tubing: Copper tubing with brazed joints.
6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:
   1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
   2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
   3. Field Piping Connection: Non-ferrous material with threaded NPT.

E. Fan and Motor Assembly:
   1. Fan(s):
      a. Direct-drive arrangement.
      b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
      c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
      d. Wheels statically and dynamically balanced.
   2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
   4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
   5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:
   1. Access: Bottom, to accommodate filter replacement without the need for tools.
   2. Efficiency: ASHRAE 52.2, MERV 8.
   3. Media:
      a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

G. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.
   1. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.
      a. Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
      b. Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.

H. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.

I. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.

J. Unit Accessories:
   1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

K. Unit Controls:
   1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
   2. Factory-Installed Controller: Configurable digital control.
   3. Factory-Installed Sensors: Unit inlet air temperature, Coil entering refrigerant temperature, Coil leaving refrigerant temperature.
   4. Field-Customizable I/O Capability:

5. Features and Functions:
   a. Self-diagnostics.
   b. Time delay.
   c. Auto-restart.
   d. External static pressure control.
   e. Auto operation mode.
   f. Manual operation mode.
   g. Filter service notification.
   h. Power consumption display.
   i. Drain assembly high water level safety shutdown and notification.
   j. Run test switch.

6. Communication: Network communication with other indoor units and outdoor unit(s).

7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

L. Unit Electrical:
   1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
   2. Field Connection: Single point connection to power entire unit and integral controls.
   3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
   4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
   5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
   6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

2.7 INDOOR, SUSPENDED, CEILING-MOUNTED UNITS

A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

B. Cabinet:
   1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
   2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
   3. Mounting: Manufacturer-designed provisions for field installation.
   4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:
   1. Coil Casing: Aluminum, galvanized, or stainless steel.
   2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
   3. Coil Tubes: Copper, of diameter and thickness required by performance.
   4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
   5. Internal Tubing: Copper tubing with brazed joints.
   6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
   7. Field Piping Connections: Manufacturer's standard.
   8. Factory Charge: Dehydrated air or nitrogen.
   9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:
   1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
   a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.
3. Field Piping Connection: Non-ferrous material with threaded NPT.

E. Fan and Motor Assembly:
   1. Fan(s):
      a. Direct-drive arrangement.
      b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
      c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
      d. Wheels statically and dynamically balanced.
   2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
   4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
   5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:
   1. Access: Front, to accommodate filter replacement without the need for tools.
   2. Efficiency: MERV 8.

G. Discharge-Air Grille Assembly: Mounted in front of unit cabinet.
   1. Discharge Pattern Adjustment: Field-adjustable limits for range of pattern.

H. Return-Air Grille Assembly: Manufacturer's standard.

I. Unit Accessories:
   1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
   2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.

J. Unit Controls:
   1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
   2. Factory-Installed Controller: Configurable digital control.
   3. Factory-Installed Sensors: Unit inlet air temperature, Coil entering refrigerant temperature, Coil leaving refrigerant temperature.
   4. Field-Customizable I/O Capability:
   5. Features and Functions:
      a. Self-diagnostics.
      b. Time delay.
      c. Auto-restart.
      d. External static pressure control.
      e. Auto operation mode.
      f. Manual operation mode.
      g. Filter service notification.
      h. Power consumption display.
      i. Drain assembly high water level safety shutdown and notification.
      j. Run test switch.
   6. Communication: Network communication with other indoor units and outdoor unit(s).
   7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. Field Connection: Manufacturer’s standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

K. Unit Electrical:
1. Enclosure: Manufacturer’s standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer’s standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer’s standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

2.8 OUTDOOR, AIR-SOURCE HEAT-PUMP UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
1. Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. All units installed shall be from the same product development generation.

B. Cabinet:
1. Galvanized steel and coated with a corrosion-resistant finish.
   a. Coating with documented salt spray test performance of 1000 hours according ASTM B 117 surface scratch test (SST) procedure.
2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:
1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:
   a. High refrigerant pressure.
   b. Low oil level.
   c. High oil temperature.
   d. Thermal and overload.
   e. Voltage fluctuations.
   f. Phase failure and phase reversal.
   g. Short cycling.
3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

D. Condenser Coil Assembly:
1. Plate Fin Coils:
   a. Casing: Aluminum, galvanized, or stainless steel.
   b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
   c. Tubes: Copper, of diameter and thickness required by performance.
2. Aluminum Microchannel Coils:
b. Single- or multiple-pass arrangement.
c. Construct fins, tubes, and header manifolds of aluminum alloy.

3. Corrosion Protection: Coating with documented salt spray test performance of 1000 hours according ASTM B 117 surface scratch test (SST) procedure.

4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

E. Condenser Fan and Motor Assembly:
   1. Fan(s): Propeller type.
      a. Direct-drive arrangement.
      b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
      c. Statically and dynamically balanced.

2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.

3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.


5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.


F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

G. Unit Controls:
   1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.

2. Factory-Installed Controller: Configurable digital control.

3. Factory-Installed Sensors:
   a. Refrigerant suction temperature.
   b. Refrigerant discharge temperature.
   c. Outdoor air temperature.
   d. Refrigerant high pressure.
   e. Refrigerant low pressure.
   f. Oil level.

4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, manual operation mode, night setback control, power consumption display, run test switch, equalize run time between multiple same components.

5. Communication: Network communication with indoor units and other outdoor unit(s).

6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

H. Unit Electrical:
   1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.

2. Field Connection: Single point connection to power entire unit and integral controls.

3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.
I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevent corrosion when exposed to salt spray test for 1000 hours according ASTM B 117.

J. Unit Piping:
   1. Unit Tubing: Copper tubing with brazed joints.
   2. Unit Tubing Insulation: Manufacturer’s standard insulation, of thickness to prevent condensation.
   3. Field Piping Connections: Manufacturer’s standard.
   4. Factory Charge: Dehydrated air or nitrogen.
   5. Testing: Factory pressure tested and verified to be without leaks.

2.9 OUTDOOR, AIR-SOURCE HEAT RECOVERY UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
   1. Specially designed for use in systems with simultaneous heating and cooling.
   2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
   3. All units installed shall be from the same product development generation.

B. Cabinet:
   1. Galvanized steel and coated with a corrosion-resistant finish.
      a. Coating with documented salt spray test performance of 1000 hours according ASTM B 117 surface scratch test (SST) procedure.
   2. Mounting: Manufacturer-designed provisions for field installation.
   3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:
   1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
   2. Protection: Integral protection against the following:
      a. High refrigerant pressure.
      b. Low oil level.
      c. High oil temperature.
      d. Thermal and overload.
      e. Voltage fluctuations.
      f. Phase failure and phase reversal.
      g. Short cycling.
   3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
   5. Oil management system to ensure safe and proper lubrication over entire operating range.
   6. Crankcase heaters with integral control to maintain safe operating temperature.
   7. Fusible plug.

D. Condenser Coil Assembly:
   1. Plate Fin Coils:
      a. Casing: Aluminum, galvanized, or stainless steel.
      b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
      c. Tubes: Copper, of diameter and thickness required by performance.
   2. Aluminum Microchannel Coils:
b. Single- or multiple-pass arrangement.
c. Construct fins, tubes, and header manifolds of aluminum alloy.
3. Corrosion Protection: Coating with documented salt spray test performance of 1000 hours according ASTM B 117 surface scratch test (SST) procedure.
4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

E. Condenser Fan and Motor Assembly:
1. Fan(s): Propeller type.
   a. Direct-drive arrangement.
   b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
   c. Statically and dynamically balanced.
2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
5. Speed Settings and Control: Variable speed with a speed range of least 80 percent.

F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

G. Unit Controls:
1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:
   a. Refrigerant suction temperature.
   b. Refrigerant discharge temperature.
   c. Outdoor air temperature.
   d. Refrigerant high pressure.
   e. Refrigerant low pressure.
   f. Oil level.
4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection auto operation mode, manual operation mode, night setback control, power consumption display, run test switch, equalize run time between multiple same components.
5. Communication: Network communication with indoor units and other outdoor unit(s).
6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

H. Unit Electrical:
1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for 1000 hours according ASTM B 117.
J. Unit Piping:
   1. Unit Tubing: Copper tubing with brazed joints.
   2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
   3. Field Piping Connections: Manufacturer's standard.
   4. Factory Charge: Dehydrated air or nitrogen.
   5. Testing: Factory pressure tested and verified to be without leaks.

2.10 HEAT RECOVERY CONTROL UNITS (HRCUS)

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
   1. Specially designed for use in systems with simultaneous heating and cooling.
   2. Systems shall consist of one unit, or multiple unit that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.

B. Cabinet:
   2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
   3. Mounting: Manufacturer-designed provisions for field installation.
   4. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

D. Refrigeration Assemblies and Specialties:
   1. Specially designed by manufacturer for type of VRF HVAC system being installed, either two or three pipe.
   2. Each refrigerant branch circuit shall have refrigerant control valve(s) to control refrigerant flow.
   3. Spares: Each heat recovery control unit shall include at least two branch circuit port(s) for future use.
   4. Each system piping connection upstream of heat recovery unit shall be fitted with an isolation valve to allow for service to any heat recovery control unit in the system without interrupting operation of the system.
   5. Each branch circuit connection shall be fitted with an isolation valve and capped service port to allow for service to any individual branch circuit without interrupting operation of the system.
      a. If not available as an integral part of the heat recovery control unit, isolation valves shall be field installed adjacent to the unit pipe connection.

E. Unit Controls:
   1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
   2. Factory-Installed Controller: Configurable digital control.
   4. Communication: Network communication with indoor units and outdoor unit(s).
   5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
   6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

F. Unit Electrical:
   1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
   2. Field Connection: Single point connection to power entire unit and integral controls.
   3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

G. Unit Piping:
   1. Unit Tubing: Copper tubing with brazed joints.
   2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
   3. Field Piping Connections: Manufacturer's standard.
   4. Factory Charge: Dehydrated air or nitrogen.
   5. Testing: Factory pressure tested and verified to be without leaks.

2.11 SYSTEM CONTROLS

A. General Requirements:
   1. Network: Indoor units, HRCUs, and outdoor units shall include integral controls.
   3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:
      a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.
      b. Integration devices shall be connected to local uninterruptible power supply unit(s) to provide at least 5 minutes of battery backup operation after a power loss.
      c. Integration shall include control, monitoring, scheduling, change of value notifications
   4. Operator Interface:
      a. Operators shall interface with system and unit controls through the following:
         1) Operator interfaces integral to controllers.
         2) Web interface through web browser software.
         3) Integration with Building Automation System.
      b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:
         1) On/off control.
         2) Temperature set-point adjustment.
   5. Refer to Sequence of Operation specifications for requirements of system control. Coordinate with building automation system and provide all necessary control interface equipment, components, etc. to meet sequence of operation and associated monitoring and adjustment.

2.12 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:
   1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
   2. ASHRAE 34, Class A1 refrigerant classification.

B. Oil:
   1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

2.13 SYSTEM CONDENSATE DRAIN PIPING

A. If more than one material is listed, material selection is Contractor's option.

B. Copper Tubing:
1. Drawn-Temper Tubing: According to ASTM B 88, Type L or Type DWV according to ASTM B 306.

2.14 SYSTEM REFRIGERANT PIPING
A. Comply with requirements in Section 232300 "Refrigerant Piping" for system piping requirements.

2.15 PIPING AND TUBING INSULATION
A. Comply with requirements in Section 230700 for system piping insulation requirements.

2.16 SYSTEM CONTROL CABLE
A. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables" for control wiring and cable raceways.
B. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for control wiring and cable raceways.

2.17 SOURCE QUALITY CONTROL
A. Factory Tests: Test and inspect factory-assembled equipment.
B. Equipment will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.
C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.
D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.
E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.
F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.
G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION, GENERAL
A. Clearance:
   1. Maintain manufacturer's recommended clearances for service and maintenance.
   2. Maintain clearances required by governing code.
B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with
equipment, that are not factory mounted.

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.
B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from
structure above using threaded rods; minimum rod size of 3/8 inch.
C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.
D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish
or replaced damaged areas after units are installed.
E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above
ceilings.
F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to
provide a neat and finished appearance.
G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch.
H. For wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power
serving units within walls.

3.4 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.
B. Install outdoor units on support structures indicated on Drawings.
C. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases.
   1. Attachment: Install anchor bolts to elevations required for proper attachment to supported
equipment.
   2. Grouting: Place grout under equipment supports and make bearing surface smooth.
D. Roof-Mounted Installations: Install outdoor units on equipment supports. Anchor units to supports
   with removable, stainless-steel fasteners.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and
   tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on
   coordination drawings.
B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment
   rooms and service areas.
C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited
   unless specifically indicated otherwise.
D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel
   removal.
E. Install piping and tubing to permit valve servicing.
F. Install piping and tubing at indicated slopes.
G. Install piping and tubing free of sags.
H. Install fittings for changes in direction and branch connections.
I. Install piping and tubing to allow application of insulation.
J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 “Sleeves and Sleeve Seals for HVAC Piping.”

L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 “Escutcheons for HVAC Piping.”

3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:
   1. Install a union in piping at each threaded unit connection.
   2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
   3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:
      a. Details indicated on Drawings.
      b. Manufacturer’s requirements.
      c. Governing codes.
      d. In the absence of requirements, comply with requirements of ASHRAE handbooks.
   4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
   5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:
   1. Slope piping from unit connection toward drain termination at a constant slope of not less than one percent.

C. Pumped Drains:
   1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.7 INSTALLATION OF REFRIGERANT PIPING

A. Refrigerant Tubing Kits:
   1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.
   2. Support tubing using hangers and supports indicated at intervals not to exceed 5 feet Minimum rod size, 1/4 inch.
   3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.

B. Install refrigerant piping according to ASHRAE 15 and governing codes.

C. Select system components with pressure rating equal to or greater than system operating pressure.

D. Install piping as short and direct as possible, with a minimum number of joints and fittings.

E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.

F. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

G. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:
1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps to entrain oil in vertical runs.
4. Liquid lines may be installed level.

H. When brazing, remove or protect components that could be damaged by heat.

I. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

J. Joint Construction:
   1. Ream ends of tubes and remove burrs.
   2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
      a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
      b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.8 INSTALLATION OF PIPING AND TUBING INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Installation to maintain a continuous vapor barrier.

B. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

E. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 INSTALLATION OF DUCT, ACCESSORIES, AND AIR OUTLETS

A. Where installing ductwork adjacent to equipment, allow space for service and maintenance.

B. Comply with requirements for metal ducts, air duct accessories, flexible ducts, air diffusers and registers and grilles specified in appropriate sections.

3.10 ELECTRICAL INSTALLATION

A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.
B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.
   1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.

C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

E. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

F. Install nameplate or acrylic label with self-adhesive back for each electrical connection indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate shall be laminated phenolic layers of black with engraved white letters. Letters at least 1/2 inch high.
   2. Locate nameplate or label where easily visible.

G. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or revised in this Section.
   1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 deep.
   2. Outlet boxes for cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
   3. Flexible metal conduit shall not be used.

H. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

I. Install manufactured conduit sweeps and long-radius elbows if possible.

J. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.11 SOFTWARE

A. Cybersecurity:
   1. Software:
      a. Coordinate security requirements with IT department.
      b. Ensure that latest stable software release is installed and properly operating.
      c. Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols at least eight characters in length. Record passwords and turn over to party responsible for system operation and administration.
   2. Hardware:
      a. Coordinate location and access requirements with IT department.
      b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
      c. Disable dual network connections.

3.12 INSTALLATION OF SYSTEM CONTROL CABLE

A. Comply with NECA 1.

B. Installation Method:
   1. Install cables in raceways except as follows:
      a. Within equipment and associated control enclosures.
      b. In accessible ceiling spaces where open cable installation method may be used.
      c. In gypsum board partitions where cable may be enclosed within wall cavity.
2. Conceal raceway and cables except in unfinished spaces.

C. General Requirements for Cabling:
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable.
5. Cables serving a common system may be grouped in a common raceway. Install control cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
11. Support: Do not allow cables to lie on removable ceiling tiles or access panels.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
15. Do not bend cables in a radius less than 10 times the cable OD.
16. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
17. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

D. Balanced Twisted-Pair Cable Installation:
2. Do not untwist balanced twisted-pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

E. Open-Cable Installation:
1. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
2. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources: Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded cable from potential EMI sources including electrical power wiring and equipment.

3.13 FIRESTOPPING
A. Comply with requirements in Section 078413 "Penetration Firestopping."
B. Comply with TIA-569-D, Annex A, "Firestopping."
C. Comply with BICSI TDMM, "Firestopping" Chapter.
3.14 GROUNDING INSTALLATION

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.15 IDENTIFICATION

A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 230553 "Identification for HVAC Piping and Equipment."

B. Identify system electrical and controls components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   1. Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.

3.16 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.
   1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.
      a. Additional factory-authorized representatives may assist with completion of certain activities only if supervised by manufacturer's employee. A factory-authorized representative shall not provide assistance without manufacturer's employee supervision.
   2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit
      a. First Visit: Kick-off meeting.
      b. Second Visit: At approximately 25 percent completion of system(s).
      c. Third Visit: At approximately 50 percent completion of system(s).
      d. Fourth Visit: At approximately 75 percent completion of system(s).
      e. Fifth Visit: Final inspection before system startup.
   3. Kick-off Meeting:
      a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
      b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
      c. Meeting shall cover the following as a minimum requirement:
         1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
         2) Manufacturer's installation requirements specific to systems being installed.
         3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
         4) Required field activities related installation of VRF HVAC system.
         5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.
   4. Site Visits: Activities for each site visit shall include the following:
      a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
      b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.

d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.

e. Issue a report for each visit, documenting the visit.
   1) Report to include name and contact information of individual making the visit.
   2) Date(s) and time frames while on-site.
   3) Names and contact information of people meeting with while on-site.
   4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:
   a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.
   b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
   c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
   d. Inspection reports for indoor units shall include, but not be limited to, the following:
      1) Unit designation on Drawings.
      2) Manufacturer model number.
      3) Serial number.
      4) Network address, if applicable.
      5) Each equipment setting.
      6) Mounting, supports, and restraints properly installed.
      7) Proper service clearance provided.
      8) Wiring and power connections correct.
      9) Line-voltage reading(s) within acceptable range.
     10) Wiring and controls connections correct.
     11) Low-voltage reading(s) within an acceptable range.
     12) Controller type and model controlling unit.
     13) Controller location.
     14) Temperature settings and readings within an acceptable range.
     15) Humidity settings and readings within an acceptable range.
     16) Condensate removal acceptable.
     17) Fan settings and readings within an acceptable range.
     18) Unit airflow direction within an acceptable range.
     19) If applicable, fan external static pressure setting.
     20) Filter type and condition acceptable.
     21) Noise level within an acceptable range.
     22) Refrigerant piping properly connected and insulated.
     23) Condensate drain piping properly connected and insulated.
     24) If applicable, ductwork properly connected.
     25) If applicable, external interlocks properly connected.
     26) Remarks.
   e. Inspection reports for outdoor units shall include, but not be limited to, the following:
      1) Unit designation on Drawings.
      2) Manufacturer model number.
      3) Serial number.
      4) Network address, if applicable.
      5) Each equipment setting.
      6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Condensate removal acceptable.
13) Noise level within an acceptable range.
14) Refrigerant piping properly connected and insulated.
15) Condensate drain piping properly connected and insulated.
16) Remarks.

f. Installer shall provide manufacturer with the requested documentation and technical support during inspection.
g. Installer shall correct observed deficiencies found by the inspection.
h. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.
i. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
j. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.5 times VRF HVAC system operating pressure, but not less than 600 psig, using dry nitrogen.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
4. Prepare test report to record the following information for each test:
   a. Name of person starting test, company name, phone number, and e-mail address.
   b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
   c. Detailed description of extent of tubing tested.
   d. Date and time at start of test.
   e. Test pressure at start of test.
   f. Outdoor temperature at start of test.
   g. Name of person ending test, company name, phone number, and e-mail address.
   h. Date and time at end of test.
   i. Test pressure at end of test.
   j. Outdoor temperature at end of test.
   k. Remarks:
5. Submit test reports for Project record.
D. Refrigerant Tubing Evacuation Testing:
   1. Comply with more stringent of VRF HVAC system manufacturer's requirements and
      requirements indicated.
   2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of
      500 microns.
   3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of
      one hour(s) with no change.
   4. Prepare test report to record the following information for each test:
      a. Name of person starting test, company name, phone number, and e-mail address.
      b. Name of manufacturer's service representative witnessing test, company name, phone
         number, and e-mail address.
      c. Detailed description of extent of tubing tested.
      d. Date and time at start of test.
      e. Test pressure at start of test.
      f. Outdoor temperature at start of test.
      g. Name of person ending test, company name, phone number, and e-mail address.
      h. Date and time at end of test.
      i. Test pressure at end of test.
      j. Outdoor temperature at end of test.
      k. Remarks:
   5. Submit test reports for Project record.
   6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:
   1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall
      consult variable refrigerant system manufacturer to determine the correct system refrigerant
      charge.
   2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
   3. System refrigerant charging shall be witnessed by system manufacturer's representative.
   4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor
      unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.17 STARTUP SERVICE

A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup
   service.
   1. Service representative shall be a factory-trained and -authorized service representative of VRF
      HVAC system manufacturer.
   2. Complete startup service of each separate system.
   3. Complete system startup service according to manufacturer's written instructions.

B. Startup checks shall include, but not be limited to, the following:
   1. Check control communications of equipment and each operating component in system(s).
   2. Check each indoor unit's response to demand for cooling and heating.
   3. Check each indoor unit's response to changes in airflow settings.
   4. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.
   5. Check sound levels of each indoor and outdoor unit.

C. Installer shall accompany manufacturer's service representative during startup service and provide
   manufacturer's service representative with requested documentation and technical support during
   startup service.
   1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:
1. After completion of startup service, manufacturer shall issue a report for each separate system.
2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.
   a. All available system operating parameters shall be included in the information submitted.

### 3.18 ADJUSTING

A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.
B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.
C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.
D. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.19 PROTECTION

A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.
B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.
C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.
D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

### 3.20 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
   1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

### 3.21 DEMONSTRATION

A. Engage a VRF HVAC system manufacturer's employed training instructor or factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.
B. Schedule and Duration:
   1. Schedule training with Owner at least 20 business days before first training session.
   2. Training shall occur before Owner occupancy.
   3. Training shall be held at mutually agreed date and time during normal business hours.
   4. Each training day shall not exceed eight hours of training. Daily training schedule shall allow time for one hour lunch period and 15 minute break after every two hours of training.
   5. Perform not less than 16 total hours of training.
C. Location: Owner shall provide a suitable on-site location to host classroom training.
D. Training Attendees: Assume three people.

E. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee’s name, signature, phone number, and e-mail address.

F. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.

G. Training Materials: Provide training materials in electronic format to each attendee.
   1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
   2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

H. Acceptance: Obtain Commissioning Agent or Owner written acceptance that training is complete and requirements indicated have been satisfied.
SECTION 238216
AIR COILS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes the following types of air coils that are not an integral part of air-handling units:
      1. Hot-water.
      2. Chilled-water.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil.

1.4 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   B. ASHRAE Compliance:
      1. Comply with ASHRAE 15 for refrigeration system safety.
      2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
      3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

1.7 PROJECT CONDITIONS
   A. Altitude above Mean Sea Level: 662 feet

PART 2 PRODUCTS

2.1 WATER COILS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      2. Marlo Coil
      3. McQuay International
      4. Trane.
5. Aerofin Corporation.
   
   B. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.
   
   C. Minimum Working-Pressure/ Temperature Ratings: 200 psig, 325 degrees F.
   
   D. Source Quality Control: Factory tested to 300 psig.
   
   E. Tubes: ASTM B 743 copper, minimum 0.020 inch thick.
   
   F. Fins: Aluminum, minimum 0.0075 inch thick.
   
   G. Frames: Galvanized-steel channel frame, minimum 0.0625 inch thick for flanged mounting.
   
   H. Casing: Galvanized casing for coil and drain pan with integral drain pan and water/drain connections.
   
   I. Refer to drawings for coil capacities and characteristics:

PART 3 EXECUTION

3.1 EXAMINATION
   
   A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
   
   B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
   
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   
   A. Install coils level and plumb.
   
   B. Install coils in metal ducts and casings constructed according to SMACNA’s “HVAC Duct Construction Standards, Metal and Flexible.”

   C. Install stainless-steel drain pan under each cooling coil and encased within duct system the coil is installed in
      1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
      2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
      3. Extend drain pan upstream and downstream from coil face.
      4. Extend drain pan under coil headers and exposed supply piping.

   D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.

   E. Straighten bent fins on air coils.

   F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS
   
   A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

   B. Install piping adjacent to coils to allow service and maintenance.

   C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section “Instrumentation and Control for HVAC,” and other piping specialties are specified in Division 23 Section “Hydronic Piping.” Refer to coil piping details for valve and specialty requirements.
SECTION 238236
FINNED-TUBE RADIATION HEATERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes:
   2. Electric finned-tube radiators.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Shop Drawings:
   1. Include plans, elevations, sections, and details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include details and dimensions of custom-fabricated enclosures.
   4. Include enclosure joints, corner pieces, access doors, and other accessories.
C. Samples: For each exposed product and for each color and texture specified.
D. Color Samples for Initial Selection: For finned-tube radiation heaters with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural members, including wall construction, to which finned-tube radiation heaters will be attached.
   2. Method of attaching finned-tube radiation heaters to building structure.
   3. Penetrations of fire-rated wall and floor assemblies.
B. Field quality-control reports.

PART 2 PRODUCTS

2.1 HOT-WATER FINNED-TUBE RADIATION HEATERS
A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Jaga North America
   2. Runtal North America
B. Performance Ratings: Rate finned-tube radiation heaters according to Hydronics Institute’s "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."
C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One end of tube shall be belled.
   1. Refer to the Finned Tube Radiation schedule on the drawings for:
a. Tube Diameter  
b. Fin Size  
c. Fin Spacing  
d. Number of Tiers  
e. Heat Output  
f. Entering-Air Temperature  

D. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.

E. Front Panel: Minimum 0.0528-inch-thick steel.

F. Wall-Mounted Back Panel: Minimum 0.0329-inch-thick steel, full height, with full-length channel support for front panel without exposed fasteners.

G. Floor-Mounted Pedestals: Conceal insulated piping at maximum 36-inch spacing. Pedestal-mounted back panel shall be solid panel matching front panel. Provide stainless-steel escutcheon for floor openings at pedestals.

H. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

I. Finish: Baked-enamel finish in manufacturer's custom color as selected by Architect.

J. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

K. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes. Provide end caps and cover sections for seamless and continuous appearance of fin tube between walls.

2.2 ELECTRIC FINNED-TUBE RADIATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Berko Electric Heating; a division of Marley Engineered Products.
   2. Chromalox; a division of Emerson Electric Company.
   3. Indeeco.
   4. Markel Products; a division of TPI Corporation.
   5. Marley Electric Heating; a division of Marley Engineered Products.
   6. Ouellet Canada Inc.
   7. Qmark Electric Heating; a division of Marley Engineered Products.
   8. Trane.

B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.

C. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded into fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.

D. Front Panel: Minimum 0.70-inch (14-gauge) thick steel.

E. Wall-Mounting Back Panel: 14-gauge steel, full height, with full-length channel support for front panel without exposed fasteners.

F. Support Brackets: Locate at maximum 36-inch spacing to support unit.

G. Finish: Baked-enamel finish in manufacturer's custom color as selected by Architect.

H. Extended Enclosure with Access Doors: Factory made extended enclosure for mounting of controls and disconnect, with removable panel for access.

I. Enclosure Style: Flat top.
   1. Bottom Inlet Opening: Punched louver; painted to match enclosure.
   2. Top Outlet Grille: Punched louver; painted to match enclosure.
J. Unit Controls: Integral low-voltage relay and control transformer for remote thermostat.

K. Operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

L. Electrical Connection: Factory wire motors and controls for a single field connection.

M. Accessories: Integral disconnect switch, filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes. Provide end caps and cover sections for seamless and continuous appearance of fin tube between walls.

N. Refer also to Mechanical Electrical Coordination schedule for electrical connection requirements including but not limited to starters, disconnects, wiring, installation, interconnections, etc.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of finned-tube radiation heaters.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FINNED-TUBE RADIATION HEATER INSTALLATION

A. Install units level and plumb.

B. Install enclosure continuously around corners, using outside and inside corner fittings.

C. Where recessed between walls at punched opens, install enclosure continuously between walls with access cover to valving.

D. Join sections with splice plates and filler pieces to provide continuous enclosure.

E. Install access doors for access to valves.

F. Install enclosure continuously from wall to wall. Elements shall be centered on windows. Elements shall be equally proportioned beneath multiple windows.

G. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

H. Install valves within reach of access door provided in enclosure.

I. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

J. Install piping within pedestals for freestanding units.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water finned-tube radiation heaters and components to piping according to Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties."

1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Install control valves as required by Section 230900 "Instrumentation and Control for HVAC."

D. Install piping adjacent to finned-tube radiation heaters to allow service and maintenance.
E. Ground electric convection heating units according to Division 26 Section “Grounding and Bonding.”

F. Connect wiring according to Division 26 Section “Conductors and Cables.”

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION
SECTION 238239.13
CABINET UNIT HEATERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes cabinet unit heaters with centrifugal fans and hot-water coils.

1.3 DEFINITIONS
A. BAS: Building automation system.
B. CWP: Cold working pressure.
C. PTFE: Polytetrafluoroethylene plastic.
D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Shop Drawings:
   1. Include plans, elevations, sections, and details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include location and size of each field connection.
   4. Include details of anchorages and attachments to structure and to supported equipment.
   5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
C. Samples: For each exposed product and for each color and texture specified.
D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

1.5 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Floor plans reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which cabinet unit heaters will be attached.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
6. Perimeter moldings for exposed or partially exposed cabinets.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit-Heater Filters: Furnish one spare filter for each filter installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Airtherm; a Mestek company.
3. Rittling
4. Sigma Corporation
5. Sterling
6. Trane Incorporated

2.2 DESCRIPTION

A. Factory-assembled and -tested unit complying with AHRI 440.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 2021.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 COIL SECTION INSULATION

A. Insulation Materials: Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.

1. Thickness: 1/2 inch.
2. Thermal Conductivity (k-Value): 0.24 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
4. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
2.5 CABINETS

A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch-thick sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch-thick sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessed Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.
5. Base: Minimum 0.0528-inch-thick steel, finished to match cabinet, 4 inches high with leveling bolts.
6. Extended Piping Compartment: 8-inch-wide piping end pocket.
7. False Back: Minimum 0.0428-inch-thick steel, finished to match cabinet.

2.6 FILTERS

A. Minimum Arrestance: According to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Pleated: 90 percent arrestance and MERV 7.

2.7 COILS

A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

2.8 CONTROLS

A. Fan and Motor Board: Removable.
1. Fan: Forward curved, high static, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

B. Control devices and operational sequences are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence of Operations for HVAC Controls."

C. BAS Interface Requirements:
1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at central workstation.
3. Interface shall be BAC-net compatible for central BAS workstation and include the following functions:
   a. Adjust set points.
   b. Cabinet unit-heater start, stop, and operating status.
   c. Room-air temperature.
   d. Occupied and unoccupied schedules.
   e. Fan enable/disable

D. Electrical Connection: Factory-wired motors and controls for a single field connection.
1. Provide NEMA-1 disconnect switch for each Cabinet Unit Heater
2. Provide motor starter for each cabinet unit heater.

2.9 CAPACITIES AND CHARACTERISTICS

A. Refer to the Cabinet Unit Heater Schedule on the drawings.
2.10 ELECTRICAL CONNECTION
A. Refer also to Electrical Coordination schedule for electrical connection requirements. Electrical connection requirements include, but are not limited to, variable speed drives, disconnects, voltage, controls/switching.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."
B. Install cabinet unit heaters to comply with NFPA 90A.
C. Suspend cabinet unit heaters from structure with elastomeric hangers.
D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS
A. Piping installation requirements are specified in Section 232113 "Hydronic Piping," Section 232116 Hydronic Piping Specialties," Drawings indicate general arrangement of piping, fittings, and specialties.
B. Comply with safety requirements in UL 1995.
C. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
D. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of cabinet unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties."
E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL
A. Perform the following tests and inspections:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
B. Units will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

END OF SECTION
SECTION 238239.16  
PROPELLER UNIT HEATERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes propeller unit heaters with hot-water coils.

1.3 DEFINITIONS
A. BAS: Building automation system.
B. CWP: Cold working pressure.
C. PTFE: Polytetrafluoroethylene plastic.
D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Shop Drawings:
   1. Include plans, elevations, sections, and details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include location and size of each field connection.
   4. Include details of anchorages and attachments to structure and to supported equipment.
   5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
   6. Include location and arrangement of piping valves and specialties.

1.5 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which propeller unit heaters will be attached.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
B. Field quality-control reports.
PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Airtherm; a Mestek company.
   3. Trane Inc.
   4. Sterling

2.2 DESCRIPTION
A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PERFORMANCE REQUIREMENTS
A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 HOUSINGS
A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.
B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.5 COILS
A. General Coil Requirements: Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.
B. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.
C. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
   1. Circuit Protection: One-time fuses in terminal box for over-current protection and limit controls for high-temperature protection of heaters.
   2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

2.6 FAN AND MOTOR
A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

2.7 CONTROLS
A. Fan and Motor Board: Removable.
1. Fan: Forward curved, high static, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

B. Control devices and operational sequences are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence of Operations for HVAC Controls."

C. Electrical Connection: Factory-wired motors and controls for a single field connection.

2.8 CAPACITIES AND CHARACTERISTICS
A. Refer to propeller unit heater schedule on drawings.

2.9 ELECTRICAL CONNECTION
A. Refer also to Electrical Coordination schedule for electrical connection requirements. Electrical connection requirements include, but are not limited to, variable speed drives, disconnects, voltage, controls/switching.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install propeller unit heaters to comply with NFPA 90A.
B. Install propeller unit heaters level and plumb.
C. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS
A. Piping installation requirements are specified in Section 232113 "Hydronic Piping." Section 232116 Hydronic Piping Specialties," Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to machine to allow service and maintenance.
C. Connect piping to propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
D. Comply with safety requirements in UL 1995.
E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties."

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare startup, test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following humidifiers:
   1. Electric Steam Humidifiers

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, and details of components, manifolds, and attachments to other work.

C. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

D. Field quality-control test reports

E. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ARI 640, "Commercial and Industrial Humidifiers."

1.5 COORDINATION

A. Coordinate location and installation of humidifiers with manifolds in air-handling units. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 – PRODUCTS

2.1 ELECTRIC STEAM HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Dri-Steem Corporation.
   2. Nortec/Condair Industries, Inc.
   3. Pure Humidifier Company
4. Carel USA

B. Packaged unit, wall mounted, with built in blower pack for direct space humidification.

C. Unit[s] to be complete with:
   1. Self-generating electrode type steam humidifier producing atmospheric steam inside a plastic cylinder without the use of immersion type electric heating elements.
   2. Disposable plastic steam cylinder with published life expectancy shall be constructed of UL Listed plastic with minimum 94HB safety rating and Zinc plated low carbon steel electrodes.
   3. Electrical connection to electrodes shall be plug type connector fusion molded on cylinder top. Screw down connectors may loosen and/or cause leaks overtime and therefore are not acceptable.
   4. Auto-Adaptive control system to optimize contained water conductivity, control automatic drain/flush cycles, minimizes energy waste and maximizes cylinder life.
   5. High water sensor to prevent over filling and detect water level in the unit.
   6. Full cylinder indication light to advise end of cylinder life.
   7. Output rated at 8.0 lbs/hr at 220-240V, 6.9 lbs/hr at 208V and 4.0 lbs/hr at 110-120V.
   8. Fill valve, drain valve and fill assembly with minimum 1 inch air gap.
   9. Flexible domestic cold water supply tube with fittings, drain hoses, and clamps.
   10. Fault indication lights.
   11. Drain water tempered by fill water to ensure drains do not exceed 140°F during standard operation.
   12. Enclosed cabinet, flame retardant grade polycarbonate construction allows user full front access.
   13. Fully modulating output between 20% and 100% of rated capacity.
   14. Limited manual capacity adjustment of 20%.
   15. Two year limited warranty.
   17. UL Listed.

D. Optional accessories:
   1. Refer to options schedule.

E. Drain Valve: 3/4-inch stainless steel ball valve for manual draining the humidifier reservoir.

F. Operational sequences are specified in Division 23 Sections "Sequence of Operations for HVAC Controls."

G. BAS Interface Requirements:
   1. Provide interface for central BAS workstation for all humidifier setpoints and monitors.
   2. Interface relay to provide indication of fault at the central workstation.

H. Controls: Programmable microprocessor controller, factory mounted and wired on the cover of the control panel. The control cabinet shall have a factory wired time delay relay circuit. The delay circuit shall prevent cycling of the low water interlock circuit due to water fluctuations within the humidifier reservoir.
   1. Microprocessor Control: All operations will be microprocessor based with and include a key pad/digital display module. The system will include the following features and functions:
      a. Numeric display indicating:
         1) Actual room or space RH (adjustable)
         2) Humidistat set point (adjustable)
         3) High limit humidistat set point (adjustable)
         4) Total system demand (% of unit capacity)
         5) Total system output (lbs. /hr)
         6) PI loop (adjustable)
I. Condensate Drain Cooler: Stainless steel water-tempering device that mixes cold water with hot condensate / water discharged from unit to reduce the discharged water temperature to below 140°F. Include supports.

J. Support Legs: As required for installation.

K. Refer to equipment schedule for capacities and characteristics.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install humidifiers according to manufacturer’s written instructions, ARI 640, and the project drawings.

B. Install humidifiers with required clearance for service and maintenance.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Install piping adjacent to humidifiers to allow service and maintenance.
   2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.

B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.

C. Ground equipment according to 26 Section "Grounding and Bonding"

D. Connect wiring according to Division 26 Section "Conductors and Cables."

E. Connect to building automation system for remote monitoring and control.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes dust collectors and associated explosion control system.
B. Related Sections include the following:
   1. Division 23 Section “Sequence of Operation for HVAC Controls”
   2. Division 26 Sections for power supply wiring including disconnects, motor starters, and required electrical devices.
C. Work of this Section includes the power and control wiring between the remote control panel and the dust collector. Refer to Division 26 Sections for requirements.

1.3 PERFORMANCE REQUIREMENTS
A. Project Altitude: Base air ratings on sea level elevations.
B. Operating Limits: Classify centrifugal fans according to AMCA 99.
C. Dust Collector Unit Schedule: Refer to the Drawings and Schedules for capacity, static pressure, motor requirements, electrical characteristics, and accessories.

1.4 SUBMITTALS
A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material gages and finishes, including color charts.
   5. Filter media. Type and area.
   6. Dampers, including housings, linkages, and operators.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
C. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
D. Coordination Drawings: Show dust collector layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
E. Maintenance Data: For dust collectors to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver dust collectors as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural steel support members.

B. Coordinate installation of roof equipment supports, and roof penetrations. These items are specified in Division 5 and Division 7 Sections.

1.8 WARRANTY

A. Warranty: 10-year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Donaldson Company, Inc.: Torit Products

2.2 MANUFACTURED UNITS

A. Description: Factory-fabricated, -assembled, -tested, and -finished, dust collector consisting of housing, hopper/support section, filter module with cartridge elements, centrifugal fan and motor, self-cleaning system, compressed air connections, and accessories. Dust collector shall be an aspirated cartridge, continuously operating, self-cleaning type.

B. Construction: Unit constructed of 7- and 10-gage steel; major sections shall be modular bolted construction with tool-less quick-open access doors. Housing rated for +/- 20.00 inches w.g.

C. Filter Module: Filter module with cartridge filter elements, reverse pulse cleaning system, clean air plenum, and cartridge removal/replace replacement sealing hardware with support frame and side walls. Provide a staggered channel inlet baffle in the high entry cross-flow entry plenum to provide diffusion of the inlet airstream and to protect the cartridges from coarse and mildly abrasive materials.

D. Filter Media: Flame Retardant "Fibra-Web FR" cartridges. 99% filtration efficiency on one-micron particles. Filters shall be removable without the use of tools.

E. Compressed Air Self-Cleaning System: Blow pipes, internal piping, compressed air header, solenoid valves, diaphragm valves factory-installed. P4 Photohelic control panel in NEMA 4X enclosure for remote mounting includes photohelic gage/switch to trigger reverse-pulse cleaning on demand. Provide factory compressed air filter and regulator.
   1. Provide cold climate kit with heating elements to prevent cold weather freeze up. All wiring shall be done by the manufacturer and Div 23 through the dust collector unit control panel.

G. Discharge Hopper: 12 gauge steel. One hopper. Hopper square on top, octagonal on bottom and slide gate. shall be bridge free and have no internal ledges. Discharge hopper attaches to drum cover with latches.
   1. Dust Storage: 55 gallon drum.
   2. Provide dust storage drum connector assembly with flex hose and drum attachment.

H. Support leg structure: Legs shall provide 48" clearance below hopper discharge flange.

I. Control Panel: Provide control panel housing motor starter, motor circuit protection for fan motor, control transformer, pulse cleaning controls, start/stop buttons, flange mounted disconnect switch, and filter pressure drop controller.
   1. Pressure drop controller shall include the following features:
      a. Digital readout display
      b. Continuous filter cleaning capability
      c. Filter restriction and cleaning control
      d. 4-20 mA output card for remote pressure drop monitoring and interface with BAS
      e. No battery backup required
      f. Dry contact for remote monitoring of alarms and fan motor status on BAS.
   2. Provide contacts for remote operation of dust collector.
   3. Start/Clean/Stop: Provide Nema 12 (indoor location) start/clean/stop controls in the control panel housing. Also, include a remote push button control for start/clean/stop.

J. Fan Outlet Silencer: Sound attenuator mounted directly to fan outlet. Designed to reduce fan noise below 80 dbA at 5 feet.

K. Factory Finish: Unit parts individually painted prior to assembly, with a second finish coat applied after assembly. There shall be no bare metal surfaces on any part of the unit.
   1. Paint: Powder coat, black color

L. Factory provided disconnect.

M. Pulse Dampening System
   1. Quantity: Prove one compressed air pulse dampening system
   2. Basis-of-Design Product: Donaldson Torit Model PDP-0009SP
   3. Components
      a. Prefilter
      b. Desiccant dryer
      c. Afterfilter
      d. Control System
      e. Automatic condensate drain
      f. 3-gallon reciever

N. Additional Accessories:
   1. Inlets/ outlets: standard (round)
   2. Explosion vent flange
   3. Solenoid enclosure: Nema 4
   4. Explosion vent: Qty 1
   5. Vent weather cover: top mounted
   6. Sprinkler coupling
   7. Ground test documentation
   8. Outlet Damper
2.3 EXPLOSION SUPPRESSION SYSTEM

A. General: Include an explosion suppression system manufactured by Fenwal Protection Systems for the dust collector.

B. The explosion suppression system shall meet the following design parameters:
   1. Material: Common wood dust
   2. Maximum explosion pressure: 10.0 bar
   3. Explosion rate constant: 150 bar m/s
   4. Autoignition temperature: 300 °C

C. Control Unit: EX200 Single Zone in a NEMA 4 enclosure with 24 hour battery backup. Operates on 120 Volt AC power fed from dust collector controller. Include dry contacts for remote signaling of alarm and trouble conditions.

D. Pressure Detection: One pair of static pressure detectors on flexible standoff kits.

E. Suppression: One PF1000 PistonFire with conical spreader. Pressurize suppressors with 900 PSIG of dry nitrogen and charge with KIDDEX dry chemical suppressant. Include flanged stainless steel conical shaped spreader nozzles. Include OSHA lockout/tagout cables.

F. Isolation: One PF1000 PistonFire with single exist head and hose assembly

G. Process Interlock: Automatic shutdown of duct collector equipment.

H. Design Verification: Include the assistance of a factory trained representative to visit the site prior to installation to coordinate with Division 23 to verify the final component locations.

I. Commissioning: Include factory start-up and commissioning of the system by a factory trained representative. Include point-to-point wiring checks, pressure tests, calibration of the detectors, and arming the system.

2.4 MOTORS

A. Comply with the requirements of Division 23 Section "Motors."

B. Motor Construction: Continuous duty, premium efficiency.

C. Explosion Proof Motor

D. Enclosure Type: Totally enclosed, fan cooled.

2.5 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

2.6 ELECTRICAL CONNECTION

A. Refer also to Electrical Coordination schedule for electrical connection requirements. Electrical connection requirements include, but are not limited to, variable speed drives, disconnects, voltage, controls/switching.

2.7 BUILDING AUTOMATION SYSTEM INTERFACE

A. Refer also to Sequence of Operation for necessary control and interface requirements.
PART 3 - EXECUTION

3.1 INSTALLATION
A. Install dust collector units level and plumb in accordance with manufacturer’s instructions.
   1. Support units on structural steel supports as detailed. Supports are specified in Division 5 and Division 7 Sections. Coordinate sizes and locations of supports.
B. Install units with clearances for service and maintenance.
C. Label dust collector according to requirements specified in Division 23 Section "Mechanical Identification."
D. Provide a plastic laminate sign per Division 23 section "Identification for HVAC Piping and Equipment" with the following text: "TBD"

3.2 CONNECTIONS
A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Install ducts adjacent to fans to allow service and maintenance.
B. Install the remote control panel including the interconnecting power and control wiring between the panel and the dust collector.
C. Connect compressed air for cartridge cleaning system.
D. Coordinate the installation and connection of dust collector motor starter and disconnect. Power and supply wiring are work of Division 26.
E. Refer to Division 23 Section “Sequence of Operation for HVAC Controls” for connection requirements to the BAS.
F. Refer to Division 23 Section “Sequence of Operation for HVAC Controls” for unit power and operational interlock requirements.
G. Ground equipment.
H. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.
B. Dust Collector and Explosion Control System: Division 23 to install all components of the system, including all interconnecting wiring and controls. Division 26 will provide line voltage power to the control panel and the dust collector motor only.

3.3 FIELD QUALITY CONTROL
A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.4 CLEANING
A. On completion of installation, internally clean units according to manufacturer’s written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
3.5 DEMONSTRATION

A. Engage a factory service representative to train Owner’s maintenance personnel to adjust, operate, and maintain centrifugal fans.
   1. Train Owner’s maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
   2. Review data in maintenance manuals. Refer to Division 1 Section “Closeout Procedures.”
   3. Schedule training with Owner, through Architect, with at least seven days’ advance notice.

END OF SECTION
Project Manual for

Wayne State University
Gateway Theater Complex

Vol. 3
Detroit, Michigan
WSU Proj. No. 189-178578
HAA Proj. No. 2016034.00

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Design Architect / MEP Engineer
HGA
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Minneapolis, MN 55401

Structural Engineering
DESAI / NASR Consulting Engineers
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West Bloomfield, MI 48322

Civil Engineer
Spalding DeDecker
905 South Blvd. East
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Theatrical / Lighting
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Issued for PERMIT SET
29 JUNE 2020
1.1 DESIGN PROFESSIONALS OF RECORD

ARCHITECT: Hamilton Anderson

PLUMBING/ HVAC ENGINEER: HGA

ELECTRICAL ENGINEER: HGA
STRUCTURAL ENGINEER  Desai Nasr

CIVIL ENGINEER  Spalding DeDecker  Thomas Sovel

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**END OF SECTION**
SECTION 260500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

A. BUILDING SYSTEMS COMMISSIONING
   1. “An independent third party Commissioning Agent will document completion of the Plumbing, HVAC, and Electrical Systems for the project. The Construction Manager and Division Contractors are members of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to section 019113 Building Systems Commissioning for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team.”

1.2 SUMMARY
   A. Section Includes:
      1. Electrical equipment coordination and installation.
      2. Common electrical installation requirements.
      3. Demolition.
      4. Cutting and patching for electrical construction.
      5. Concrete bases.
      7. Touchup painting.

1.3 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   B. Comply with NFPA 70.
   C. Comply with State and/or City Code requirements.
   D. All materials shall meet the standards of the following institutes where applicable:
      1. National Fire Protection Association (NFPA)
      2. American Society of Testing Materials (ASTM)
      3. American National Standards Institute (ANSI)
      4. National Electrical Manufacturer’s Association (NEMA)
      5. Institute of Electrical and Electronic Engineers (IEEE)

1.4 COORDINATION
   A. Coordinate arrangement, mounting, and support of electrical equipment:
      1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
      2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
      3. To allow right of way for piping and conduit installed at required slope.
      4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
   B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Section 083100 "Access Doors and Panels."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 078413 "Penetration Firestopping."

E. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
   1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

F. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

G. Coordinate electrical service connections to components furnished by utility companies.
   1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
   2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

H. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability. Document results of said testing.

1.5 DRAWINGS

A. The drawings indicate the arrangements of electrical equipment. Review architectural drawings and details for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness. All devices, raceway, and electrical equipment in finished and/or public spaces shall be recessed or concealed unless otherwise noted.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans and details unless indicated on Electrical plans.

C. Bring all discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Architect.

D. Equipment layout is based on one manufacturer's product or from composite dimensions from multiple manufacturers. Where equipment selected for use on the job differs from layout, coordinate space requirements and connection arrangements.

1.6 EQUIPMENT REQUIRING ELECTRICAL SERVICE

A. Review all specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to all such equipment requiring electrical service.

B. Drawings indicate design loads, voltages and corresponding control equipment, feeders, and overcurrent devices. If equipment actually furnished have loads other than those indicated on the drawings or specified herein, control equipment, feeders, and overcurrent devices shall be adjusted in size accordingly at no additional cost to the owner. Such adjustment shall be subject to the review of the Architect.
C. Incidental items not indicated on Drawing or mentioned in Specifications but that can legitimately and reasonably be inferred to belong to the Work or be necessary in good practice to provide complete system, shall be furnished and installed though not itemized here in detail.

1.7 MECHANICAL SYSTEMS INTERFACE

A. All control wiring for plumbing, heating, ventilating and air conditioning systems shall be installed under Division 23. Review Division 23 specifications and shop drawings for control systems to assure compatibility between equipment furnished under Division 23 and wiring furnished under Division 26.

B. Motor controllers (starters) shall be furnished and installed under Division 26, unless specified to be furnished as an integral component of the equipment. Provide the number and type of auxiliary contacts necessary to interlock the equipment and provide the specified control sequence.

C. Power wiring to all motors, motor controllers and between motors and controllers shall be provided in Division 26.

D. All electric heating equipment shall be provided and installed under Division 23 - HEATING, VENTILATING AND AIR CONDITIONING. Power wiring to all electric heating equipment shall be provided under Division 26 of these specifications.

1.8 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project. Existing systems and conditions which are not detailed on the drawings must still be restored to their original condition.

1.9 EQUIVALENTS AND SUBSTITUTIONS

A. The applicable paragraphs for General Requirements, Division 01 apply herein.

B. Basis of Design: The manufacturer’s name and product listed on the drawings, or listed first of several names in these Specifications, is used as a basis for design to establish space requirements, a standard of quality and performance.

C. Equivalents: Products of one or more other manufacturer’s names listed in these Specifications following the words “or equivalent by” may be selected, subject to paragraph below titled “Contractor’s Responsibility for Equivalent and Substitutions”.

D. Other Options:
   1. For products specified by naming only one manufacturer, refer to paragraph below under “Substitutions”.
   2. For products specified only by performance characteristics or reference standards, select any manufacturer meeting the requirements.

E. Substitutions: Requests for acceptance of a product of manufacturer’s name not listed in these Specifications will be considered if any one of the following conditions is met:
   1. The named product is not available because of strikes or discontinuance of manufacture; and the proposed product is equivalent to the named product.
   2. The proposed product is superior to the named product, in the opinion of the Owner’s Representative.
3. The proposed product is equivalent to the named product and its use will be to the advantage of the Owner, by the Owner receiving an equitable credit or cost savings. The Owner’s Representative reserves the right to reject any substitution.

4. Submit proposed substitutions with bid along with alternate price, complete descriptive data and a comparison of the substitute manufacturer’s product with specified product. Request for acceptance of a product of manufacturer’s name not listed in these Specifications, is subject to the paragraph titled “Contractor’s Responsibility Equivalents and Substitutions”.

F. Contractor’s Responsibility for Equivalents and Substitutions:

1. Items submitted as a substitution to the Basis of Design or listed general equivalents shall be identified as such and shall include a written request for substitution indicating the following:
   b. Contract time adjustment.
   c. Item by item breakdown of differences between Basis of Design and substituted item.
   d. Operation, maintenance and energy cost difference.

2. Products of manufacturer must match the features, construction, performance and size of those selected for design. Standard catalogued may require certain modifications to meet specified requirements.

3. The responsibility for providing that specified requirements have been met remains with the manufacturer and Contractor. Should the substituted item fail to perform in accordance with the Specifications, replace same with the originally specified item without extra cost to the contract.

4. When requesting review of an equivalent or substituted product, submit a comparison chart listing features, construction, performance and sizes of name product versus equivalent or substituted product.

5. Submittals for review of an equivalent or substituted product will be reviewed for acceptability when all the above requirements have been met. Contractor shall be responsible for all costs incurred by the Architect and Engineer for review of equivalency beyond initial review.

6. Coordinate the installation of the product with all trades.

7. Contractor shall be responsible for changes in electric wiring, materials and for all other additional costs of construction by all trades involved to accommodate the product to perform the same as the product used in the “Basis of Design”.

8. Coordination of General Equivalents and Substitutions: Where Contract Documents permits selection from general equivalents, or where substitutions are authorized, coordinate clearance and other interface requirements with other work.

9. Provide necessary additional items so that selected or substituted item operates equivalent to the Basis of Design and properly fits in the available space allocated for the Basis of Design.

10. Contractor is responsible for assuring that piping, conduit, duct, flue and other service locations for general equivalents or substitutions do not cause access, service or operational difficulties any greater than would be encountered with the Basis of Design.

11. Failure to comply with these requirements will result in immediate rejection of the request for substitution.

1.10 COORDINATION WITHIN DIVISION 26

A. Contract Documents:

1. General: The Contract Documents are diagrammatic showing certain physical relationships, which must be established within Division 26 work and its interface with other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing dimensions, clearances or material quantities.

2. Supplemental Instructions: The exact location for some items in this Specification may not be shown on the Drawings. The location of such items may be established by the Owner’s Representative during the progress of the work.

3. Discrepancies:
a. Examine Drawings and Specifications of all Divisions of the work.
b. Report any discrepancies to the Owner’s Representative and obtain written instructions before proceeding.
c. Should there be a conflict within or between the Specifications or Drawings, the most stringent or higher quality requirements shall apply.
d. Items called for either in the Specifications or on the Drawings shall be required as if called for in both.

4. Constructability:
   a. Examine Drawings and Specifications of all Divisions of the work.
   b. Report any issues to the Owner’s Representative which may prevent installation of Division 26 work in accordance with the Contract Documents and the original construction contract.

B. Contractor shall be responsible for providing proper documentation of equipment product data and shop drawings to all entities providing service.

C. Coordination Drawings: Prepare coordination drawings in accordance with Division 01, Section “Submittals” to scale of 1/4” = 1’-0” or larger, detailing major elements, components, and systems of mechanical equipment (i.e. equipment rooms, and exterior equipment areas) and materials in relationship with other system, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important to the efficient flow of the work, including (but not necessarily limited to) the following:
   1. Indicate all major electrical equipment and conduits, piping (HVAC, Plumbing and Fire Suppression), structural, and architectural elements in these areas as well.
   2. Sizes and locations of required concrete pads, piers, curbs, and bases.
   3. Provide all necessary sections and elements for clarification.
   4. Failure to produce or submit coordination drawings does not dismiss the Contractor’s responsibility for translating the design intent of the Contract Documents into Construction Drawings.

1.11 COORDINATION WITH OTHER DIVISIONS

A. General:
   1. Coordinate the Division 26 work with the progress of the work of the other trades.
   2. Complete the entire installation as soon as the condition of the building will permit.
   3. Contractor is responsible for coordination of his/her work with Owner’s facility staff engaged in building automation, commissioning of systems, fire alarm system, etc.

B. Chases, Inserts and Openings:
   1. Provide measurements, drawings, and layouts so that opening, inserts and chases in new construction can be built and coordinated as construction progresses.
   2. Check sizes and locations of openings provided.
   3. Any cutting and patching made necessary by failure to provide measurements, drawings, and layouts at the proper time shall be done at no additional cost to the Owner.

C. Support Dimensions: Provide dimensions and drawings so that concrete bases and other equipment supports to be provided under other Sections of the Specifications can be built at the proper time.

1.12 GENERAL SUBMITTAL REQUIREMENTS

A. Refer to Division 01 for additional requirements.

B. Coordination and Sequencing:
   1. Coordinate submittals 3 weeks (minimum) prior to expected order date so that work will not be delayed by submittals.
2. Do not submit product data, or allow its use on the project until compliance with requirement of Contract Documents has been confirmed by Contractor.
3. Submittal is for information and record, unless otherwise indicated, and is not a change order request.
4. Submitting contractor is responsible for routing reviewed submittals to all parties affected including but not limited to electrical, building automation and temperature control, and test and balance subcontractors.
5. Make submittals for group of similar products or materials or by area of work complete and at one time, not in piecemeal fashion.
6. Identify submittals with Architect’s project name and number, with item designation as indicated on drawings, and referenced to applicable paragraphs of the specifications. Submit in brochure form.
7. Submittals of products needed to start of Project for its installation, or those requiring a long lead time for assembly or manufacturing, should be submitted before the others.

C. Preparations of Submittals:
1. Refer to Division 01 requirements.
2. Provide permanent marking on each submittal to identify project, date, Contractor, Subcontractor, Supplier, submittal name and similar information to distinguish it from other submittals.
3. Indicate any portions of work, which deviate from the Contract Documents.
   a. Explain the reasons for the deviations.
   b. Show how such deviations coordinate with interfacing portions of other work.
4. Show Contractor’s executed review and approval marking.
5. Provide space for the Owner’s Representative “Action” marking.
6. Submittals, which are received from sources other than through Contractor’s office, will be returned “Without Action”.
7. Submittals shall be presented in a neat and legible fashion and shall be returned “Without Action” if presented in any other fashion.

D. Response to Submittals: Where standard product data has been submitted, it is recognized:
1. That the Submitter has determined that the products fulfill the specified requirements.
2. That the submittal is for the Owner’s Representative information only, but will be returned with appropriate action where observed to be not in compliance with the requirements.

E. If more than two submittals (either for shop drawings, or test reports) are made by the Contractor due to the incompletion, non-compliance, errors, omissions, etc. the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

1.13 RECORD DRAWINGS
A. Record drawings shall meet all “As-built” and “Record Drawings” requirements for Tennessee State Museum. Coordinate all requirements with State of Tennessee staff prior to completion.

B. Drawings:
1. Record of Project progress: Maintain drawings available at the job site for inspection. Keep an accurate, legible and continuously updated record of installed locations and all project revisions other than revised drawings issued by the Architect, including source and date of authorization. Utilize only contract drawing symbols for recording the work. Drawing notations to be sufficiently clear in the representation of the work, for utilization by a CADD operator (drafts person) who is not necessarily familiar with the installed work.
2. Record of Installation: At the conclusion of the work, deliver one (1) set of updated drawings to the Owner’s Representative for review. Following the review, Contractor shall have incorporated by a competent CADD operator all of the installed data represented on the project progress drawings.
3. Include in Record Drawings the Following:
   a. Revisions, including sketches, bulletins, change orders, written addenda and directives, clarifications and responses generated by requests for information (RFIs), regardless of source of the revision.
   b. Location and configuration of equipment with related housekeeping pads.
   c. Physical routing of ductbank work, raceways, exposed and above ceilings with locations of fire dampers, combination fire/smoke dampers, smoke detectors, power supplies, etc., plainly marked and identified.
   d. Location of room controllers, switches, devices, and sensors.
   e. Physical routing of raceways, underground, exposed and above ceiling with locations of accessories, pull points, access points plainly marked and identified.
   f. Location of raceways below building and on exterior, accessories, manholes, appurtenances and stub outs dimensioned from buildings and permanent structures, both horizontally and vertically.
   g. Location of wall and ceiling access panels.

1.1 NOISE CRITICAL SPACES
   A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces:

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<th>SPACE</th>
<th>ROOM CRITERIA (NC)</th>
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<tr>
<td>Proscenium Theater</td>
<td>TBD</td>
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<tr>
<td>Jazz Center</td>
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   B. Penetrations by ducts, pipes, wiring and conduit between noise critical spaces shall be sleeved, packed and sealed airtight with non-hardening sealant.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION
   A. Comply with NECA 1.
   B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
   C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
   D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
   E. Right of Way: Give to piping systems installed at a required slope.
   F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
3.2 FIRESTOPPING
A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 078413 "Penetration Firestopping."

3.3 CUTTING AND PATCHING
A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.4 FLOOR PENETRATIONS
A. In mechanical rooms above grade: electrical penetrations shall have 4” high water stopped curbs or sleeves around the penetration. Refer also to structural drawings for pre-located penetrations at perimeter of mechanical rooms with curbs. Where not feasible to locate penetrations at perimeter, provide a sealed sleeve for penetration that shall extend a minimum of 1-1/2” above the floor.
B. Seal all floor penetrations air and water tight. Provide sealant materials to meet code penetrations requirements.

3.5 CONCRETE BASES
A. Concrete Bases and Curbs:
   1. Provide scaled layouts of bases and curbs with sizes and locations dimensioned to concrete walls and columns.
   2. Determine base and curb sizes and locations based on “Accepted” equipment shop drawings. Base and curb sizes shall not be scaled from the Drawings.
   3. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic requirements at Project.
B. Construction Details: Refer also to Architectural Details for base and curb construction types. If not indicated, construct as follows:
   1. Provide concrete bases sized 4 inches larger in both directions than the supported equipment.
   2. Provide 4-inch high curbs and bases with finished edges.
   3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   6. Install anchor bolts to elevations required for proper attachment to supported equipment.
   7. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   8. Use 3000-psi, 28-day compressive-strength concrete and reinforcement.
   9. Chamfer all outside corners of concrete bases and curbs.
C. Concrete Base Painting: Provide 3” wide safety stripe at outside edge of concrete bases and curbs. Start paint at bottom edge of chamfer. Color shall be selected by architect.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES
A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
B. Field Welding: Comply with AWS D1.1.

### 3.7 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:
   1. Firestopping.
   2. Cutting and patching for electrical construction.
   3. Touchup painting.

### 3.8 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Section 099000 "Painting."
   1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
   2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
   3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

### 3.9 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

**END OF SECTION**
SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS
    A. Drawings and general provisions of the Contract, including General and Supplementary Conditions
       and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
    A. Section Includes:
       1. Copper building wire rated 600 V or less.
       2. Metal-clad cable, Type MC, rated 600 V or less.
       3. Armored cable, Type AC, rated 600 V or less.
       4. Connectors, splices, and terminations rated 600 V and less.
    B. Related Requirements:
       1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications
          cables and Classes 1, 2 and 3 control cables.
       2. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for
          data circuits.
       3. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for
          data circuits.

1.3 DEFINITIONS
    A. RoHS: Restriction of Hazardous Substances.
    B. VFC: Variable frequency controller.

1.4 ACTION SUBMITTALS
    A. Product Data: For each type of product.
    B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS
    A. Qualification Data: For manufacturer's authorized service representative.
    B. Field quality-control reports.

PART 2 PRODUCTS

2.1 COPPER BUILDING WIRE
    A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an
       overall insulation layer or jacket, or both, rated 600 V or less.
    B. Manufacturers: Subject to compliance with requirements, available manufacturers offering prod-
       ucts that may be incorporated into the Work include, but are not limited to, the following:
       1. Alpha Wire.
       2. Belden Inc.
       3. Cerro Wire
4. Okonite Company (The)
5. Southwire Incorporated.
6. United Copper Industries.

C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Conductor Insulation:
1. Type RHW-2: Comply with UL 44.
2. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
3. Type THHN and Type THWN-2: Comply with UL 83.
4. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
5. Type UF: Comply with UL 83 and UL 493.
6. Type XHHW-2: Comply with UL 44.

F. Shield:
1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems.
2. Allied.
3. Anixter.
4. Kat-Tech
5. Service Wire Co.

C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
F. Ground Conductor: Insulated.

G. Conductor Insulation:
   1. Type TFN/THHN/THWN-2: Comply with UL 83.
   2. Type XHHW-2: Comply with UL 44.

H. Armor: Steel, interlocked.

I. Jacket: PVC applied over armor for connections mounted exterior of the building.

2.3 ARMORED CABLE, TYPE AC

A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems.
   2. Allied.
   3. Anixter
   4. Kaf-Tech
   5. Okonite Company (The)
   7. Southwire Incorporated.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.

H. Armor: Steel, interlocked.

2.4 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. 3M Electrical Products
   2. AFC Cable Systems, Inc.
   5. Ideal Industries, Inc.
   6. ILSCO
   7. NSi Industries LLC.
8. O-Z/Gedney; a brand of the EGS Electrical Group.
10. TE Connectivity Ltd.
11. Thomas & Betts Corporation

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
   1. Material: Copper.
   2. Type: Two hole with standard barrels.
   3. Termination: Compression.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

E. Branch Circuits: Copper. Stranded for No. 12 AWG and larger.

F. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.


3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.

C. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

D. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

F. VFC Output Circuits: Type TC-ER cable with braided shield.
   1. Provide a separate grounding conductor to the drive and from the drive to the motor to ensure a continuous ground path to the building source of supply.
2. Provide separate continuous ferrous metallic conduits for the line, load, and control conductors for VSD's. Provide ferrous metallic shielding around each separate VSD conductor group when installed with other conductor in a raceway, wireway, or pullbox.

3. Shielded conductor group cable assemblies specifically designed for VSD use is acceptable and shall meet the following requirements.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Group conductors with phases A, B, C, and neutral together in all conduits or raceways regardless of number of sets of conductors, conduits or raceway type.

H. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three branch circuits are to be installed in any one conduit, on 3 phase 4 wire system, unless specifically indicated otherwise on the drawings. No two branch circuits of the same phase are to be installed in the same conduit, unless specifically indicated on the drawings. Where the quantity of wires is not indicated on the drawings for branch circuits (2) #12 copper conductors shall be provided.

I. Conductor size shall be a minimum of No. 12 AWG. Conductor size shall not be less than indicated on the drawings. The minimum size of emergency systems conductors shall be No. 10 AWG. 60 deg. C ampacities shall be used for sizing all wire and cable for feeders rated 100 amps and below. 75 deg. C ampacities shall be used for sizing of all wire and cable for feeders rated over 100 amps. This sizing requirement applies to all cables in these size ranges, including those with higher insulation ratings. Use No. 10 AWG for conductors in 120 volt 20 amp branch circuits longer than 100 feet (30 m), and in 277 volt 20 amp branch circuits longer than 200 feet (60 m).

J. Do not use AC or MC for homeruns. Use conduit from last box in wall or ceiling back to panel.

K. Splicing feeder conductors in a new installation is not allowed.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

D. Stranded conductors shall have termination device crimped onto conductors prior to connection to outlet devices or installed with back-wired devices listed for stranded.
3.5 IDENTIFICATION
A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS
A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Perform the following tests:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
   2. Perform each of the following visual and electrical tests:
      a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
      b. Test bolted connections for high resistance using one of the following:
         1) A low-resistance ohmmeter.
         2) Calibrated torque wrench.
         3) Thermographic survey.
      c. Inspect compression-applied connectors for correct cable match and indentation.
      d. Inspect for correct identification.
      e. Inspect cable jacket and condition.
      f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
      g. Continuity test on each conductor and cable.
      h. Uniform resistance of parallel conductors.
   3. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
      a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
   4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
C. Cables will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports to record the following:
   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
END OF SECTION
SECTION 260523
CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Backboards.
   2. Category 5e twisted pair cable.
   3. Category 6a twisted pair cable.
   4. Twisted pair cabling hardware.
   5. RS-485 cabling.
   6. Low-voltage control cabling.
   7. Control-circuit conductors.
   8. Identification products.

1.3 DEFINITIONS
A. EMI: Electromagnetic interference.
B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
D. RCDD: Registered Communications Distribution Designer.
E. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
B. Source quality-control reports.
C. Field quality-control reports.
1.6 QUALITY ASSURANCE

PART 2 PRODUCTS

2.0 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.1 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Section 061000 “Rough Carpentry.”

B. Painting: Paint plywood on all sides and edges with flat white latex paint. Comply with requirements in Section 099000 “Painting.”

2.2 CATEGORY 5E BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ADC.
   2. Alpha Wire Company; a division of Belden Inc.
   3. Belden Inc.
   4. Berk-Tek
   5. CommScope, Inc.
   6. Draka Cableteq USA.
   7. General Cable.
   8. Genesis Cable Products; Honeywell International, Inc.
   9. Mohawk; a division of Belden Inc.
   10. Nexans; Berk-Tek Products.
   11. Siemon Company (The).
   12. Superior Essex Inc.
   13. SYSTIMAX Solutions; a CommScope, Inc. brand.
   14. 3M.
   15. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

D. Conductors: 100-ohm, 24 AWG solid copper.

E. Shielding/Screening: Shielded twisted pairs (FTP).

F. Cable Rating: Plenum.

G. Jacket: Gray thermoplastic.

2.3 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.
   1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated Cable: NFPA 70, Type CMP.
   1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Unshielded.
   4. Fluorinated ethylene propylene jacket.
   5. Flame Resistance: Comply with UL 1685.

2.4 LOW-VOLTAGE CONTROL CABLE
A. Paired Cable: NFPA 70, Type CMG.
   1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with NFPA 262.

2.5 CONTROL-CIRCUIT CONDUCTORS
A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Encore Wire Corporation.
   2. General Cable Technologies Corporation.

A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

B. Class 2 0-10V Control Circuits Installed with Class 1 Conductors: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

2.6 SOURCE QUALITY CONTROL
A. Factory test twisted pair cables according to TIA-568-C.2.
B. Cable will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 EXAMINATION
A. Test cables on receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.
3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
   1. Outlet boxes for cables shall be no smaller than 4 inches (102 mm) square 2-1/8 inches (53 mm) deep with extension ring sized to bring edge of ring to within 1/8 inch (3.1 mm) of the finished wall surface.
   2. Flexible metal conduit shall not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard if entering the room from overhead.
   4. Extend conduits 3 inches (75 mm) above finished floor.
   5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70.

B. General Requirements for Cabling:
   2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
   3. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
   4. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
   5. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
   7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   10. Support: Do not allow cables to lay on removable ceiling tiles.
   11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
12. Provide strain relief.
13. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
14. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:
2. Install termination hardware as specified in Section 271513 “Communications Copper Horizontal Cabling” unless otherwise indicated.
3. Do not untwist balanced twisted pair cables more than 1/2 inch (12 mm) at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:
1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 “Raceways and Boxes for Electrical Systems.”

E. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 30 inches (760 mm) apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Below each feed point, neatly coil a minimum of 72 inches (1830 mm) of cable in a coil not less than 12 inches (305 mm) in diameter.

G. Separation from EMI Sources:
1. Comply with BICSI TDDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches (305 mm).
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches (305 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches (1200 mm).

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 REMOVAL OF CONDUCTORS AND CABLES
   A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.5 CONTROL-CIRCUIT CONDUCTORS
   A. Minimum Conductor Sizes:
      1. Class 1 remote-control and signal circuits; No. 14 AWG.
      2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
      3. Class 3 low-energy, remote-control, alarm, and signal circuits; No. 12 AWG.

3.6 FIRESTOPPING
   A. Firestopping: Provided by Section 078400 “Firestopping.” Coordinate with Section 078400 “Firestopping” for sealing of penetrations through fire and smoke barriers in accordance with requirements of TIA-569-B, Annex A, "Firestopping" and BICSI TDMM, "Firestopping" Chapter.
   B. Comply with requirements in Section 078400 "Firestopping."
   C. Comply with TIA-569-B, Annex A, "Firestopping."
   D. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING
   A. For data communication wiring, comply with ANSI-J-STD-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
   B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION
   A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.
   C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.9 FIELD QUALITY CONTROL
   A. Perform the following tests and inspections.
B. Tests and Inspections:
   1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross-connection.
      a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
   D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
   E. Prepare test and inspection reports.

END OF SECTION
SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes grounding and bonding systems and equipment.
   1. Foundation steel electrodes.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
   1. Test wells.
   2. Ground rods.
B. Qualification Data: For testing agency and testing agency's field supervisor.
C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017800 "Closeout Submittals," include the following:
      a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
         1) Test wells.
         2) Ground rods.
         3) Ground rings.

1.6 QUALITY ASSURANCE
A. Testing Agency Qualifications: Certified by NETA.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with UL 467 for grounding and bonding materials and equipment.
2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 3M
2. Alanwire
3. Burndy
4. Cerrowire
5. Erico
6. Galvan
7. General Cable Technologies Corporation.
8. Harger
9. Hilti
10. Hubbell
11. Ilsco
12. Lyncole
13. Panduit
15. Thomas & Betts
16. United Copper Industries.

2.3 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2.

D. Bare Copper Conductors:
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
   7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

E. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless [compression] [exothermic]-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

E. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

F. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

G. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

H. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

I. Conduit Hubs: Mechanical type, terminal with threaded hub.

J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

K. Lay-in Lug Connector: Mechanical type, [aluminum] [copper rated for direct burial] terminal with set screw.

L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

N. Straps: Solid copper, cast-bronze clamp. Rated for 600 A.

O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal two-piece clamp.

P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

Q. Water Pipe Clamps:
   1. Mechanical type, two pieces with [zinc-plated] [stainless-steel] bolts.
      a. Material: [Tin-plated aluminum] [Die-cast zinc alloy].
      b. Listed for direct burial.
   2. U-bolt type with malleable-iron clamp and [copper ground connector] [copper ground connector rated for direct burial].

R. Compression Connectors: Irreversible type, copper or copper alloy connectors, meet or exceed IEEE837, UL467, and CSA22.2, factory filled with oxide inhibitor compound, and marked and approved for Direct Burial. Connectors must be fully crimped, allowing visible inspection of the embossed index number on the crimped connector, which should match the same index number on the die. May be used above and below grade, on electrodes, and in concrete encased applications.
   1. Thomas & Betts Easy Ground Figure 6 Connector, Easy Ground Figure 8 Connector, Easy Ground C-Taps, Easy Ground C-Crimps.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet (19 mm by 3 m).
   1. Ground rods to have knurled pattern at clamp or compression connection.

PART 3 EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
   1. Bury at least 24 inches (600 mm) below grade.
C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

D. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Irreversible compression or welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.

3.2 GROUNDING AT THE SERVICE
A. The existing service has been

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS
A. Comply with IEEE C2 grounding requirements.

3.4 EQUIPMENT GROUNDING
A. Install insulated equipment grounding conductors with all feeders and branch circuits.
B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway runs.
   7. Armored and metal-clad cable runs.
C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
F. Metallic Fences: Comply with requirements of IEEE C2.
   1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.

3.5 FENCE GROUNDING
A. Fence Grounding: Install at maximum intervals of 50 feet (15.2 m) except as follows:
1. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 50 feet (15.2 m).
   a. Gates and Other Fence Openings: Ground fence on each side of opening.
      1) Bond metal gates to gate posts.
      2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.

C. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

D. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
   2. Use exothermic welds for all below-grade connections.
   3. Rod to have knurled area for clamp or compression connection. Knurl may be field installed with tool made for purpose.
   4. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use irreversible compression or exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

G. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of [20 feet (6 m)] <Insert dimension> of bare copper conductor not smaller than [No. 4] <Insert number> AWG.
   1. If concrete foundation is less than [20 feet (6 m)] <Insert dimension> long, coil excess conductor within base of foundation.
   2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building’s grounding grid or to grounding electrode external to concrete.

H. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

I. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at individual ground rods. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
   4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

G. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION
SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Steel slotted support systems.
   2. Aluminum slotted support systems.
   3. Conduit and cable support devices.
   4. Support for conductors in vertical conduit.
   5. Structural steel for fabricated supports and restraints.
   6. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
   7. Fabricated metal equipment support assemblies.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
      a. Slotted support systems, hardware, and accessories.
      b. Clamps.
      c. Hangers.
      d. Sockets.
      e. Eye nuts.
      f. Fasteners.
      g. Anchors.
      h. Saddles.
      i. Brackets.
   2. Include rated capacities and furnished specialties and accessories.
B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.
   2. Slotted support systems.
   3. Equipment supports.
   4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
C. Delegated-Design Submittal: For hangers and supports for electrical systems.
   1. Include design calculations and details of trapeze hangers.
1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Ductwork, piping, fittings, and supports.
   3. Structural members to which hangers and supports will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Luminaires.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Projectors.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014500 "Quality Control," to design hanger and support system.
   1. Component Importance Factor: 1.5.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame Rating: Class 1.
   2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-(10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.
2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channel Width: Selected for applicable load criteria.
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Cooper Industries.
   b. Flex-Strut, Inc.
   c. Haydon Corporation
   d. MKT Metal Manufacturing
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
5. Channel Width: Selected for applicable load criteria.
6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.


2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
   1. NECA 1.
   2. NECA 101
   3. NECA 102.
   4. NECA 105.
   5. NECA 111.

B. Comply with requirements in Section 078400 "Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.
F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC and may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Touchup: Comply with requirements in Section 099000 "Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
SECTION 260533
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Metal wireways and auxiliary gutters.
   3. Surface raceways.
   5. Handholes and boxes for exterior underground cabling.
B. Related Requirements:
   1. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS
A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS
A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.
C. Samples: For wireways and surface raceways and for each color and texture specified, 12 inches (300 mm) long for all raceway mounted in public areas.

1.5 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
B. Qualification Data: For professional engineer.
C. Source quality-control reports.
PART 2 PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AFC Cable Systems, Inc.
      b. Allied Tube & Conduit; a Tyco International Ltd. Co.
      c. Anamet Electrical, Inc.
      d. Electri-Flex Company.
      e. FSR Inc.
      f. Opti-Com Manufacturing Network, Inc.
      g. O-Z/Gedney; a brand of EGS Electrical Group.
      h. Republic Conduit.
      i. Southwire Company.
      j. Thomas & Betts Corporation.
      k. Western Tube and Conduit Corporation.
      l. Wheatland Tube Company; a division of John Maneely Company.
   2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   3. IMC: Comply with ANSI C80.6 and UL 1242.
   4. EMT: Comply with ANSI C90.3 and UL 797.
   5. FMC: Comply with UL 1; zinc-coated steel.
   6. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AFC Cable Systems, Inc.
      b. Allied Tube & Conduit; a Tyco International Ltd. Co.
      c. Anamet Electrical, Inc.
      d. Bridgeport Fittings, Inc.
      e. Calconduit
      f. Electri-Flex Company.
      g. FSR Inc.
      h. Opti-Com Manufacturing Network, Inc.
      i. O-Z/Gedney; a brand of EGS Electrical Group.
      j. Perma-Cote
      k. Picoma Industries, Inc.
      l. Plasti-Bond
      m. Republic Conduit.
      n. Robroy Industries.
      o. Southwire Company.
      p. Thomas & Betts Corporation.
      q. Topaz Electric; a division of Topaz Lighting Corp.
      r. Western Tube and Conduit Corporation.
      s. Wheatland Tube Company; a division of John Maneely Company.
   2. Comply with NEMA FB 1 and UL 514B.
   3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   4. Fittings, General: Listed and labeled for type of conduit, location, and use.
   5. Fittings for EMT:
a. Material: Steel or Zinc die cast.
b. Type: Setscrew.

6. EMT Fittings Materials:
   a. All Zinc materials shall be ASTM B86 certified.
   b. All Zinc Product shall be ZAMAK #3 and/or #7 formula.
   c. All Steel shall be SAE 1050.

7. EMT Fittings Design:
   a. Zinc die cast components shall be ball burnished.
   b. Steel parts shall be zinc plated for corrosion protection.
   c. All Locknuts shall have a dual, precision machined-cut thread, reversible and possess a serrated face on each side.
   d. All set screw products shall be manufactured with a tri-drive head and staked or modified to prevent disassembly.
   e. All fitting throat diameters shall be smooth with no sharp edges or slag.
   f. Rain tight products shall have internal sealing rings to create and maintain a rain tight seal.
   g. All fittings shall be tested per UL 514B and be listed by Underwriters Laboratories.

8. Transition Fittings:
   a. All transitions fittings (go-to or from-to fittings) or fittings used to transition from one race-way type to another must be UL listed for that application.

9. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

10. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. B-Line, an Eaton business
   2. Hoffman; a Pentair company.
   4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Hubbell Incorporated; Wiring Device-Kellems
      b. Mono-Systems, Inc.
      c. Panduit Corp.
      d. Wiremold / Legrand.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Adalet.
   2. Crouse-Hinds, an Eaton business
   3. EGS/Appleton Electric.
   5. FSR Inc.
   6. Hoffman; a Pentair company.
   7. Hubbell Incorporated; Killark Division.
   8. Kraloy.
   10. Mono-Systems, Inc.
   12. Plasti-Bond
   13. RACO; a Hubbell Company.
   14. Spring City Electrical Manufacturing Company.
   15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
   17. Topaz Electric; a division of Topaz Lighting
   18. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Metal Floor Boxes:
   1. Material: Cast metal.
   2. Type: Fully adjustable.
   3. Shape: Rectangular.
   4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

K. Gangable boxes are prohibited.

L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:
   1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
   2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Armorcast Products Company.
      b. NewBasis.
      c. Oldcast Enclosure Solutions
      d. Oldcastle Precast, Inc.; Christy Concrete Products.
      e. Quazite; Hubbell Power Systems
   2. Standard: Comply with SCTE 77.
   3. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
   4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
   5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   6. Cover Legend: Molded lettering, "ELECTRIC.".
   7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Armorcast Products Company.
      b. NewBasis.
      c. Nordic Fiberglass, Inc.
      d. Oldcastle Enclosure Solutions
      e. Oldcastle Precast, Inc.; Christy Concrete Products.
      f. Quazite; Hubbell Power Systems
   2. Standard: Comply with SCTE 77.
   3. Color of Frame and Cover: Green.
   4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
7. Cover Legend: Molded lettering, "ELECTRIC."
8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
9. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.6 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: IMC.
2. Concealed Conduit, Aboveground: EMT.
3. Underground Conduit: RNC, Type EPC-80-PVC, direct buried within non drive ways/lanes. concrete encased within drive ways and lanes.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: RNC identified for such use.
3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
   d. Gymnasiums.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: ].
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use setscrew, steel or Zinc die-cast metal fittings. Comply with NEMA FB 2.10 and UL514B.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
F. Install surface raceways only where indicated on Drawings.
G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION
A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
D. Do not fasten conduits onto the bottom side of a metal deck roof.
E. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Do not install horizontal raceway runs above water and steam piping.
F. Complete raceway installation before starting conductor installation.
G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.
I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
J. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
K. Support conduit within 12 inches (300 mm) of enclosures to which attached.
L. Raceways Embedded in Slabs:
   1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
   2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
   4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
   5. Change from ENT to IMC before rising above floor.
M. Raceways Within 1 ½” of Roof Deck:
   1. All raceway shall be installed further from 1 ½” of roof deck or raceway shall be RMC or IMC.
N. Stub-ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

O. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

P. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

Q. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

R. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

S. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

T. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

U. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

V. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

W. Surface Raceways:
   1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
   2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

X. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

Y. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Conduit extending from interior to exterior of building.
   4. Conduit extending into pressurized duct and equipment.
   5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
   6. Where otherwise required by NFPA 70.

Z. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a rain-tight connection between box and cover plate or supported equipment and box.

DD. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Do not install boxes back-to-back.

EE. Locate boxes so that cover or plate will not span different building finishes.

FF. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

HH. Set metal floor boxes level and flush with finished floor surface.

II. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

JJ. Boxes installed in metal stud and sheetrock walls shall have far-side box support.

KK. Boxes shall be secured to metal studs with spring steel clamp which wraps around the entire face of the stud and digs into both sides of the stud. Clamp shall be screwed into the stud.

LL. Set outlet boxes for flush mounted devices to within 1/8" of finished wall.

MM. Minimum box size to be two gang. For installation of single gang device use properly sized mud ring with thickness to install device within 1/8" of finished wall.

NN. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312333 "Trenching and Backfilling" for pipe less than 6 inches (150 mm) in nominal diameter.
   2. Install backfill as specified in Section 312333 "Trenching and Backfilling."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312333 "Trenching and Backfilling."
   4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
   5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.

b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANOHOLEs AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line, or with anchors extending below depth of frost line of 48 inches (122 cm) below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer’s written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION
SECTION 260543
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following:
   1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
   2. Rigid nonmetallic duct.
   3. Flexible nonmetallic duct.
   4. Duct accessories.
   5. Fiberglass handholes and boxes with polymer concrete cover.
   6. Fiberglass handholes and boxes.
   8. Utility structure accessories.

1.3 DEFINITION
A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
C. Duct Bank: Two or more ducts installed in parallel, with or without additional casing materials.
D. GRC: Galvanized rigid (steel) conduit.
E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include duct-bank materials, including separators and miscellaneous components.
   2. Include ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Include accessories for manholes, handholes, boxes, and other utility structures.
   4. Include underground-line warning tape.
B. Shop Drawings:
   1. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
      a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
      b. Include duct entry provisions, including locations and duct sizes.
      c. Include cover design.
      d. Include grounding details.
      e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.
   1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
   2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Qualification Data: For professional engineer and testing agency responsible for testing non-concrete handholes and boxes.

C. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

D. Source quality-control test reports.

E. Field quality-control reports.

F. Refer to Section 018113 “Sustainable Design Requirements” for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

1.6 MAINTENANCE MATERIALS SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.8 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Owner’s written permission.

B. Ground Water: Assume ground-water level is 36 inches (900 mm) below ground surface unless a higher water table is noted on Drawings.

PART 2 PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. Coated Steel Conduit: PVC-coated IMC.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch (1 mm), minimum.

C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
3. Anamet Electrical, Inc.
4. Bridgeport Fittings, Inc.
5. Electri-Flex Company.
7. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
8. Republic Conduit.
9. Robroy Industries.
10. Southwire Company.
12. Western Tube and Conduit Corporation.

D. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ARNCO Corp.
   2. Beck Manufacturing.
   3. Carlon; a brand of Thomas & Betts.
   4. Cantex, Inc.
   5. CertainTeed Corporation.
   7. ElecSys, Inc.
   8. Electri-Flex Company.
   9. IPEX Inc.
   10. Lamson & Sessions; Carlon Electrical Products.
   11. Spiraduct/AFC Cable Systems, Inc.

B. Underground Plastic Utilities Duct: Type EPC-80-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 FLEXIBLE NONMETALLIC DUCTS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ARNCO Corp.
   2. Carlon; a brand of Thomas & Betts
   3. National Pipe & Plastics
   4. Opti-Com Manufacturing
   5. Premier Conduit

B. HDPE Duct: Type EPEC-40 HDPE, complying with NEMA TC 7 and UL 651A.
   1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.4 NONMETALLIC FIBERGLASS DUCTS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. FRE NorthEast
2. Champion Fiberglass
3. PWEagle

B. Underground Fiberglass Utilities Duct: NEMA TC 14A/B, UL 1684, Type Direct Burial Standard Wall thickness.
   1. Fiberglass conduit shall be used at all conduit stub-ups at each end of duct raceways system

2.5 DUCT ACCESSORIES
A. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Allied Tube & Conduit; a part of Atkore International
      b. CANTEX INC
      c. Carlon; a brand of Thomas & Betts
      d. IPEX USA LLC
      e. PenCell Plastics
      f. Underground Devices, Inc.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.6 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER
A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Armorcast Products Company
      b. Carson Industries LLC
      c. Christy Concrete Products
      d. Quazite: Hubbell Power System, Inc
      e. Synertech Moulded Products, Inc

B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

C. Color: Green.

D. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

G. Cover Legend: Molded lettering, as indicated for each service.

H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
J. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.7 FIBERGLASS HANDHOLES AND BOXES

A. Description: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Carson Industries LLC.
   b. Christy Concrete Products.
   c. Nordic Fiberglass, Inc.

B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

C. Color: Green.

D. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

G. Cover Legend: Molded lettering, as indicated for each service.

H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

J. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.8 SOURCE QUALITY CONTROL

A. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Earthwork." Remove and stockpile topsoil for reapplication according to Section 311000 "Earthwork."

3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Electrical Cables More Than 600 V: Type EPC-80-PVC RNC, concrete-encased unless otherwise indicated.

B. Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC RNC, concrete-encased unless otherwise indicated.

C. Duct for Electrical Branch Circuits: Type EPC-80-PVC RNC, direct-buried unless otherwise indicated.

D. Bored Underground Duct: Type EPEC-80-HDPE unless otherwise indicated.

E. Underground Ducts Crossing Paved Paths and Driveways: Type EPC-40 PVC RNC, encased in reinforced concrete.

F. Stub-ups: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:
   1. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Fiberglass-reinforced polyester resin, SCTE 77, Tier 15 structural load rating.
   2. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.
   3. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.
   4. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 312333 "Trenching and Backfilling," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area after construction vehicle traffic in immediate area is complete.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plant Procurement."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
B. Install ducts according to NEMA TCB 2.

C. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of [48 inches (1220 mm)] [12.5 feet (4 m)] [25 feet (7.5 m)], both horizontally and vertically, at other locations, unless otherwise indicated.
   1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

F. Installation Adjacent to High-Temperature Steam Lines: Where duct banks are installed parallel to underground steam lines, perform calculations showing the duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
   2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch (19 mm).
   3. Grout end bells into structure walls from both sides to provide watertight entrances.

H. Terminator Entrances to Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to terminator spacing 10 feet (3 m) from the terminator, without reducing duct line slope and without forming a trap in the line.
   2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch (19 mm).

I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

J. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

K. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

L. Concrete-Encased Ducts and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 312333 "Trenching and Backfilling" for pipes less than 6 inches (150 mm) in nominal diameter.

2. Width: Excavate trench 3 inches (75 mm) wider than duct bank on each side.

3. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.

4. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.

5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of ducts, with not less than five spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger separators approximately 6 inches (150 mm) between tiers. Secure separators to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and communications ducts.

7. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
   a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
   b. Stub-Ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
      1) Stub-ups shall be [flush with] [minimum 4 inches (100 mm) above] finished floor and minimum 3 inches (75 mm) from conduit side to edge of slab.
   c. Stub-Ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.
      1) Stub-ups shall be [flush with] [minimum 4 inches (100 mm) above] finished floor and no less than 3 inches (75 mm) from conduit side to edge of slab.

8. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

9. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

10. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inches (50 mm) between duct of like services, and 4 inches (100 mm) between power and communications ducts.

11. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
   a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
   b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (15-mm) reinforcing-rod dowels extending a minimum of 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
12. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

M. Direct-Buried Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct bank. Comply with requirements in Section 312333 "Trenching and Backfilling" for preparation of trench bottoms for pipes less than 6 inches (150 mm) in nominal diameter.

2. Width: Excavate trench 3 inches (75 mm) wider than duct on each side.

3. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade unless otherwise indicated.

4. Set elevation of bottom of duct bank below frost line.

5. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.

6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

7. Install duct with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and communications duct.

8. Elbows: Install manufactured duct elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

9. Install manufactured GRC elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
   a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
   b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
      1) Stub-ups shall be [flush with] [minimum 4 inches (100 mm)above] finished floor and minimum 3 inches (75 mm) from conduit side to edge of slab.
   c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.
      1) Stub-ups shall be [flush with] [minimum 4 inches (100 mm)above] finished floor and no less than 3 inches (75 mm) from conduit side to edge of slab.

10. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
   a. Place minimum 3 inches (75 mm) of sand as a bed for duct bank. Place sand to a minimum of 6 inches (150 mm) above top level of duct bank.
b. Place minimum 6 inches (150 mm) of engineered fill above concrete encasement of duct bank.

N. Underground-Line Warning Tape: Bury nonconducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches (300 mm) above all concrete-encased duct and duct banks and approximately 12 inches (300 mm) below grade. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below the frost line, or with anchors extending below depth of frost line of 48 inches (122 cm) below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer’s written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and concrete and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
   1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
   2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole[ and handhole] grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 “Grounding and Bonding for Electrical Systems.”

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump.
   1. Sweep floor, removing dirt and debris.
   2. Remove foreign material.

END OF SECTION
SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Color and legend requirements for raceways, conductors, and warning labels and signs.
   2. Labels.
   4. Tapes and stencils.
   5. Tags.
   7. Cable ties.
   9. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

C. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Comply with NFPA 70.
C. Comply with ANSI Z535.4 for safety signs and labels.
D. Comply with NFPA 70E and Section 260574 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.
E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
   1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:
   1. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.
   1. Color shall be factory applied.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.

C. Raceways and Cables Carrying Circuits at More Than 600 V:
   1. Black letters on an orange field.
   2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:
   1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

F. Equipment Identification Labels:
   1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
   1. Manufacturers:
      a. Brady Corporation
      b. Champion American
      c. emedco
      d. Grafolast Wire Markers
      e. Hellermann Tyton
      f. LEM Products Inc.
      g. Marking Services, Inc.
      h. Panduit Corp.
      i. Seton Identification Products

B. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- (0.08-mm-) thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
   1. Manufacturers:
      a. A’n D Cable Products
      b. Brady Corporation
      c. Brother International Corporation
      d. emedco
      e. Grafolast Wire Markers
      f. Ideal Industries, Inc.
2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

C. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Manufacturers:
   a. A'n D Cable Products
   b. Brady Corporation
   c. Brother International Corporation
   d. emedco
   e. Grafoplast Wire Markers
   f. Hellermann Tyton
   g. Ideal Industries, Inc.
   h. LEM Products Inc.
   i. Marking Services, Inc.
   j. Panduit Corp.
   k. Seton Identification Products

2. Minimum Nominal Size:
   a. 1-1/2 by 6 inches (37 by 150 mm) for raceway and conductors.
   b. 3-1/2 by 5 inches (76 by 127 mm) for equipment.
   c. As required by authorities having jurisdiction.

2.4 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

   1. Carlton Industries, LP
   2. Champion America
   3. Hellermann Tyton
   4. Ideal Industries, Inc.
   5. Marking Services, Inc.
   6. Panduit Corp.

B. Floor Marking Tape: 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

   1. Carlton Industries, LP
   2. Seton Identification Products

C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.5 TAGS

A. Write-On Tags:

   1. Carlton Industries, LP
   2. LEM Products Inc.
   3. Seton Identification Products
   4. Polyester Tags: 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment.
5. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.6 SIGNS

A. Laminated Acrylic or Melamine Plastic Signs:
   1. Manufacturers:
      a. Brady Corporation
      b. Carlton Industries, LP
      c. emedco
      d. Marking Services, Inc.
   2. Engraved legend.
   3. Thickness:
      a. For signs up to 20 sq. inches (129 sq. cm), minimum 1/16-inch- (1.6-mm-).
      b. For signs larger than 20 sq. inches (129 sq. cm), 1/8 inch (3.2 mm) thick.
      c. Engraved legend with black letters on white face.
      d. Self-adhesive.
      e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

A. Manufacturers:
   1. Hellermann Tyton
   2. Ideal Industries, Inc.
   3. Marking Services, Inc.
   4. Panduit Corp.
   B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
      1. Minimum Width: 3/16 inch (5 mm).
      2. Tensile Strength at 73 deg F (23 deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
      3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
   C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
      1. Minimum Width: 3/16 inch (5 mm).
      2. Tensile Strength at 73 deg F (23 deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
      3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
   D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.
      1. Minimum Width: 3/16 inch (5 mm).
      2. Tensile Strength at 73 deg F (23 deg C) according to ASTM D 638: 7000 psi (48.2 MPa).
      3. UL 94 Flame Rating: 94V-0.
      4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
      5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.
PART 3 EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer’s wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer’s wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
   1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
   1. Secure tight to surface of conductor, cable, or raceway.


J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

K. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
   1. "EMERGENCY POWER."
   2. "POWER."
   3. "UPS."

L. Self-Adhesive Labels:
   1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
   2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

M. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

N. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
O. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer’s written instructions.

P. Write-on Tags:
   1. Place in a location with high visibility and accessibility.

Q. Laminated Acrylic or Melamine Plastic Signs:
   1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
   2. Unless otherwise indicated, provide a single line of text with 1/2-inch (13-mm) high letters on 1-1/2-inch (38-mm) high sign; where two lines of text are required, use labels 2 inches (50 mm) high.

R. Cable Ties: General purpose, for attaching tags, except as listed below:
   1. Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Provide conduit color as specified and identify raceways and covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

<table>
<thead>
<tr>
<th>System Type</th>
<th>Conduit Color</th>
<th>Conduit Label</th>
<th>Box Covers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Power</td>
<td>Orange</td>
<td>Orange letters/white label</td>
<td>No color</td>
</tr>
<tr>
<td>Normal Power</td>
<td>No color</td>
<td>Black letter/white label</td>
<td>No color</td>
</tr>
<tr>
<td>Fire Alarm</td>
<td>Red</td>
<td>Red letters/white label</td>
<td>No color</td>
</tr>
<tr>
<td>Lighting Control</td>
<td>No color</td>
<td>Purple letters/white label</td>
<td>Purple</td>
</tr>
<tr>
<td>Communications</td>
<td>Blue</td>
<td>White letters/blue label</td>
<td>Blue</td>
</tr>
<tr>
<td>Fire Optic Cable</td>
<td>Green</td>
<td>Green letters/white label</td>
<td>No color</td>
</tr>
<tr>
<td>Building Automation</td>
<td>White</td>
<td>Blue letters/white label</td>
<td>No color</td>
</tr>
<tr>
<td>Network (LAN)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.

E. Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive labels with the conductor designation.
F. Conductors to Be Extended in the Future: Marker tape to conductors and list source.

G. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

H. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

I. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

J. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
   1. Apply to exterior of door, cover, or other access.
   2. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.

   2. Comply with Section 260574 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.

M. Operating Instruction Signs: Self-adhesive labels.

N. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

O. Equipment Identification Labels:
   1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
   2. Outdoor Equipment: Laminated acrylic or melamine sign.
   3. Equipment to Be Labeled:
Identification for Electrical Systems

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Emergency system boxes and enclosures.
e. Enclosed switches.
f. Enclosed circuit breakers.
g. Enclosed controllers.
h. Variable-speed controllers.
i. Push-button stations.
j. Contactors.
k. Remote-controlled switches, dimmer modules, and control devices.
l. Disconnects for any equipment provided by Owner or other trade.
m. All electrical equipment or devices which are not located within sight of their source of power shall have nameplates listing their source of power (panelboard or switchboard name and number) along with voltage, circuit number, and load served.

END OF SECTION
SECTION 260572
SHORT-CIRCUIT STUDIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 DEFINITIONS
A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

D. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

E. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

F. SCCR: Short-circuit current rating.

G. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.


1.4 ACTION SUBMITTALS
A. Product Data:
   1. For computer software program to be used for studies.
   2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
      a. Short-circuit study input data, including completed computer program input data sheets.
      b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
         1) Submit study report for action prior to submitting for final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
         2) Revised single-line diagram, reflecting field investigation results and results of short-circuit study.
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:
   1. For Short-Circuit Study Software Developer,
   2. For Short-Circuit Study Specialist.

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:
   1. For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
   2. The following are from the Short-Circuit Study Report:
      a. Final one-line diagram.
      b. Final Short-Circuit Study Report.
      c. Short-circuit study data files.
      d. Power system data.

1.7 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.
   1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
   2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.

F. Field Adjusting Agency Qualifications:
   1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
   2. A member company of NETA.
   3. Acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, provide software by one of the following:
   1. ESA Inc.
   2. Operation Technology, Inc.
   3. Power Analytics, Corporation.
4. SKM Systems Analysis, Inc.

B. Comply with IEEE 399 and IEEE 551.
   1. Analytical features of fault-current-study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:
   1. Protective device designations and ampere ratings.
   2. Conductor types, sizes, and lengths.
   3. Conduit material.
   4. Transformer kilovolt ampere (kVA) and voltage ratings.
   5. Motor and generator designations and kVA ratings.
   6. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
   7. Derating factors and environmental conditions.
   8. Any revisions to electrical equipment required by the study.

D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

E. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short-circuit ratings.
   2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
   3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
   5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:
   1. One-line diagram of system being studied.
   2. Power sources available.
   3. Manufacturer, model, and interrupting rating of protective devices.
   4. Conductors and conduit material.
   5. Transformer data.

G. Short-Circuit Study Output:
   1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
      a. Voltage.
      b. Calculated fault-current magnitude and angle.
      c. Fault-point X/R ratio.
      d. Equivalent impedance.
2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
   a. Voltage.
   b. Calculated symmetrical fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. Calculated asymmetrical fault currents:
      1) Based on fault-point X/R ratio.
      2) Based on calculated symmetrical value multiplied by 1.6.
      3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
   a. Voltage.
   b. Calculated symmetrical fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. No AC Decrement (NACD) ratio.
   e. Equivalent impedance.
   f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
   g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 EXECUTION

3.1 EXAMINATION

A. Obtain all data necessary for the conduct of the study.
   1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
   2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
   3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

B. Gather and tabulate the following input data to support the short-circuit study. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
   1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Obtain electrical power utility impedance at the service.
   3. Power sources and ties.
   4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
   5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
   6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
   7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
   8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or non-magnetic).
11. Derating factors.

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.
B. Calculate short-circuit currents according to IEEE 551.
C. Base study on the device characteristics supplied by device manufacturer.
D. Extent of the electrical power system to be studied is indicated on Drawings.
E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:
   1. To normal low-voltage load buses where fault current is 10 kA or less.
F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.
H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
   1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
I. Include in the report identification of any protective device applied outside its capacity.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
   1. Study results shall be used to determine coordination of series-rated devices.

1.3 DEFINITIONS
A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.
B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
C. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
E. Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
G. SCCR: Short-circuit current rating.
H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS
A. Product Data:
   1. For computer software program to be used for studies.
   2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
      a. Coordination-study input data, including completed computer program input data sheets.
      b. Study and equipment evaluation reports.
   3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
a. Submit study report for action prior to submitting for final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:
   1. For Power System Analysis Software Developer.
   2. For Power Systems Analysis Specialist.

B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
   1. The following are from the Coordination Study Report:
      a. Final one-line diagram.
      b. Final protective device coordination study.
      c. Coordination study data files.
      d. List of all protective device settings.
      e. Time-current coordination curves.

1.7 QUALITY ASSURANCE

A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications:
   1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.
   2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

F. Field Adjusting Agency Qualifications:
   1. Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.
   2. A member company of NETA.
   3. Acceptable to authorities having jurisdiction.
PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, available software developers offering software that may be used for the Work include, but are not limited to, the following:
   1. CGI CYME
   2. EDSA Micro Corporation
   3. ESA Inc.
   4. Operation Technology, Inc.
   5. Power Analytics, Corporation.
   6. SKM Systems Analysis, Inc.

B. Comply with IEEE 242 and IEEE 399.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
   1. Optional Features:
      a. Arcing faults.
      b. Simultaneous faults.
      c. Explicit negative sequence.
      d. Mutual coupling in zero sequence.

2.2 COORDINATION STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:
   1. Protective device designations and ampere ratings.
   2. Conductor types, sizes, and lengths.
   3. Transformer kilovolt ampere (kVA) and voltage ratings.
   4. Motor and generator designations and kVA ratings.
   5. Switchgear, switchboard, motor-control center, and panelboard designations.
   6. Any revisions to electrical equipment required by the study.
   7. Study Input Data: As described in "Power System Data" Article.

D. Protective Device Coordination Study:
   1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer’s data sheets for recording the recommended setting of overcurrent protective devices when available.
      a. Phase and Ground Relays:
         1) Device tag.
         2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
         3) Recommendations on improved relaying systems, if applicable.
      b. Circuit Breakers:
         1) Adjustable pickups and time delays (long time, short time, ground).
2) Adjustable time-current characteristic.
3) Adjustable instantaneous pickup.
4) Recommendations on improved trip systems, if applicable.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
   a. Power utility's overcurrent protective device.
   b. Medium-voltage equipment overcurrent relays.
   c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
   d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
   e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
   f. Cables and conductors damage curves.
   g. Ground-fault protective devices.
   h. Motor-starting characteristics and motor damage points.
   i. Generator short-circuit decrement curve and generator damage point.
   j. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels.
6. Maintain selectivity for tripping currents caused by overloads.
7. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
8. Provide adequate time margins between device characteristics such that selective operation is achieved.
9. Comments and recommendations for system improvements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the overcurrent protective device study.
1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.

2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.

3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Electrical power utility impedance at the service.

3. Power sources and ties.

4. Short-circuit current at each system bus (three phase and line to ground).

5. Full-load current of all loads.

6. Voltage level at each bus.

7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.

8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.

9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.

10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.

11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.

12. Maximum demands from service meters.

13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.

14. Motor horsepower and NEMA MG1 code letter designation.

15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).

16. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

17. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:
   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
   d. Generator thermal-damage curve.
   e. Ratings, types, and settings of utility company's overcurrent protective devices.
   f. Special overcurrent protective device settings or types stipulated by utility company.
   g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.

k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of the electrical power system to be studied is indicated on Drawings.

E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
   1. To normal low-voltage load buses where fault current is 10 kA or less.
   2. Selectively coordinate to 0.1 second. Bring any coordination challenges to the attention of the Engineer.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Motor Protection:
   1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
   2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

H. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

I. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

J. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
   1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

K. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short-circuit ratings.
   2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.
4. Include in the report identification of any protective device applied outside its capacity.

3.4 LOAD-FLOW AND VOLTAGE-DROP STUDY
A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:
   1. Determine load-flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
   2. Determine load-flow and voltage drop based on 80 percent of the design capacity of the load buses.
   3. Prepare the load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.5 MOTOR-STARTING STUDY
A. Perform a motor-starting study to analyze the transient effect of the system’s voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of the motor starting on the power system stability.
B. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and voltage sags so as not to affect the operation of other utilization equipment on the system supplying the motor.

3.6 FIELD ADJUSTING
A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.7 DEMONSTRATION
A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in the following:
   1. Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.
   2. Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.
   3. For Owner's maintenance staff certified as NETA ETT-Certified Technicians Level III or NICET Electrical Power Testing Level III Technicians, teach how to adjust, operate, and maintain overcurrent protective device settings.
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS
A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
C. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
G. SCCR: Short-circuit current rating.
H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS
A. Product Data: For computer software program to be used for studies.
B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.
   1. Arc-flash study input data, including completed computer program input data sheets.
   2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
   3. Submit study report for action prior to submitting for final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:
   1. For Power Systems Analysis Software Developer.
   2. For Power System Analysis Specialist.
   3. For Field Adjusting Agency.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:
   1. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
   2. Operation and Maintenance Procedures: In addition to items specified in Section 017800 “Closeout Submittals,” provide maintenance procedures for use by Owner’s personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
   2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society’s Certified Software Development Professional certification.

E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, available software developers offering software that may be used for the Work include, but are not limited to, the following:
   1. CGI CYME
   2. EDSA Micro Corporation
   3. ESA Inc.
   4. Operation Technology, Inc.
   5. Power Analytics, Corporation.
6. SKM Systems Analysis, Inc.

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram, showing the following:
   1. Protective device designations and ampere ratings.
   2. Conductor types, sizes, and lengths.
   3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
   4. Motor and generator designations and kVA ratings.
   5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Short-Circuit Studies."

F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Coordination Studies."

G. Arc-Flash Study Output Reports:
   1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
      a. Voltage.
      b. Calculated symmetrical fault-current magnitude and angle.
      c. Fault-point X/R ratio.
      d. No AC Decrement (NACD) ratio.
      e. Equivalent impedance.
      f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
      g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:
   1. Arcing fault magnitude.
   2. Protective device clearing time.
   3. Duration of arc.
   5. Restricted approach boundary.
   7. Working distance.
   8. Incident energy.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.
2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch (76-by-127-mm) self-adhesive equipment label for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
   1. Location designation.
   2. Nominal voltage.
   3. Protection boundaries.
      a. Arc-flash boundary.
      b. Restricted approach boundary.
      c. Limited approach boundary.
   4. Arc flash PPE category.
   5. Required minimum arc rating of PPE in Cal/cm squared.
   6. Available incident energy.
   7. Working distance.
   8. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies: Perform the Short-Circuit and Coordination studies prior to starting the Arc-Flash Hazard Analysis.
   2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573 "Coordination Studies."

C. Calculate maximum and minimum contributions of fault-current size.
   1. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
   2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
   3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
   4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.
F. Calculate the limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
   1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
   2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:
   1. When the circuit breaker is in a separate enclosure.
   2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
   2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
   3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support coordination study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
   1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Obtain electrical power utility impedance at the service.
   3. Power sources and ties.
   4. Short-circuit current at each system bus, three phase and line-to-ground.
   5. Full-load current of all loads.
   6. Voltage level at each bus.
   7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
   8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
   9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
   10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

3.4 LABELING
A. Apply one arc-flash label on the front cover for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.
B. Each piece of equipment listed below shall have an arc-flash label applied to it:
   1. Applicable panelboard and safety switch under 250 V.
C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.
   1. Indicate arc-flash energy.
   2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS
A. Install the arc-fault warning labels under the direct supervision and control of the Power System Analysis Specialist.

3.6 DEMONSTRATION
A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION
SECTION 260913
ELECTRICAL POWER MONITORING AND CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. The Hilberry Theatre requires that all electrical power monitoring to be connected to the facility Building Automation and Control System (BAS) which includes a front end web interface and centrally managed data collection server that collects data in 1 minute intervals and stores the data in 15 minute averages. All building metering shall be hardwired back to the nearest BAS Building Control cabinet located in electrical, mechanical, or storage type rooms. Data from these devices and power monitors shall be programmed through and display information on the BAS. All programming shall be coordinated with the Division 23 contractor and the State of Tennessee.

B. This project is required to meet the energy monitoring requirements as set forth in the State of Tennessee’s High Performance Building Requirements, and 2010 90.1 ASHRAE Energy Code. These guidelines require the project to monitor the energy consumption of the different types of loads within the building. These loads types are to be categorized into four different types:

1. Lighting
2. Plug load/Equipment
3. Mechanical
4. Process load (i.e. kitchen)
5. Conveyance (i.e. elevators)

Note that the mechanical loads are served from a separate power distribution branch(s) which is dedicated for mechanical system loads. Light and plug loads are served from separate distribution branches. The goal of the project is to limit the quantity of power monitors and use the software to perform additive or subtractive calculations between power monitors to calculate the lighting or plug loads in the building. Where monitoring of distribution feeders does not achieve differentiation between load categories previously identified, monitoring of individual branch circuits will be required.

C. The power monitoring strategy will consist of three basic tiers or types of power monitors (meters), Tier 1 (T1), Tier 2 (T2), and Tier 3 (T3). Refer to one-line diagrams, riser diagrams, floor plans, panelboard schedules for meter types, quantities, and locations.

1. Tier 1 – Typically monitors building services or alternative energy sources.
2. Tier 2 – Typically monitors feeders or panelboards mains.
3. Tier 3 – Branch circuit monitoring (noted in panelboard schedules).

D. The user interface will be required to categorize the various power monitors by load types, and allow the user to have the ability to group energy consumption by these load type categories.

E. Related Sections:
1. Section 230900 “Building Automation System” for control system requirements and managed data acquisition and storage.
2. Section 230993 " Sequence of Operations for HVAC Controls"

1.2 DEFINITIONS

A. Ethernet: Local area network based on IEEE 802.3 standards.

B. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

C. HTML: Hypertext markup language.
D. I/O: Input/output.

E. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.

F. LAN: Local area network; sometimes plural as "LANs."

G. LCD: Liquid crystal display.

H. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.

I. Modbus TCP/IP: An open protocol for exchange of process data.

J. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

K. PC: Personal computer; sometimes plural as "PCs."

L. rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.


O. SCADA: Supervisory Control and Data Acquisition. A PLC type device designed to collect data points from a variety of sources.

P. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

Q. THD: Total harmonic distortion.

R. UPS: Uninterruptible power supply; used both in singular and plural context.

S. WAN: Wide area network.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

B. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.
   1. Outline Drawings: Indicate arrangement of components and clearance and access requirements.
2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

5. Surge Suppressors: Data for each device used and where applied.


1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

C. Other Informational Submittals:
   1. Manufacturer’s system installation and setup guides, with data forms to plan and record options and setup decisions.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 “Operation and Maintenance Data,” include the following:
   1. Operating and applications software documentation.
   2. Software licenses.
   3. Software service agreement.
   4. Hard copies of manufacturer’s specification sheets, operating specifications, design guides, user’s guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

B. Software and Firmware Operational Documentation:
   1. Self-study guide describing the process for setting equipment’s network address; setting Owner’s options; procedures to ensure data access from any PC on the network, using a standard Web browser; and recommended firewall setup.
   2. Software operating and upgrade manuals.
   3. Software Backup: On a magnetic media or compact disc, complete with Owner-selected options.
   4. Device address list and the set point of each device and operator option, as set in applications software.
   5. Graphic file and printout of graphic screens and related icons, with legend.

C. Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or power monitoring and control revisions.

D. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.

E. Upon completion of the work, provide a complete electronic (PDF, AutoCAD) set of ‘as-built’ drawings and application software on compact disk and on the Network Supervisor (NS) hard drive. Drawings shall be provided as AutoCAD™ or Visio™ compatible files. Eight hard copies of the ‘as-built’ drawings shall be provided in addition to the documents on compact disk.
1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
   2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE
A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
B. Manufacturer Qualifications: A firm experienced in manufacturing power monitoring and control equipment similar to that indicated for this Project and with a record of successful in-service performance.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Any power monitor substitutions requests must be accompanied with the proper substitution request forms and be able to provide a live on site demonstration that their power monitor can provide and display all power monitoring data using the BAS software system. All software programming and integration between the substituted power monitor and the software system shall be the responsibility of that manufacturers power monitor, including any costs associated with hiring a Technician to collaborate, troubleshoot, or provide any assistance necessary to provide a complete and compatible power monitoring system.

1.8 COORDINATION
A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.
B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Power Monitor Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Veris Industries Electro-IndustriesSchweitzer Engineering LaboratoriesASCO SYSTEM REQUIREMENTS
A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
   2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.
B. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.

C. Interface with BAS System: Provide factory-installed hardware and software to enable the BAS system to monitor, display, and record data for use in processing reports.
   1. ASHRAE 135 (BACnet), Provide Modbus to BACnet converter communication interface shall enable the BAS operator to remotely monitor meter information from the power monitors from the operator workstation. Control features and monitoring points displayed locally at metering panel shall be available through the BAS.

2.3 APPLICATIONS SOFTWARE
A. The manufacturer selected to provide the application software shall be responsible to ensure interoperability between systems or system components, including all power monitors and multi-channel branch circuit monitors.

B. Reporting: User commands initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
   1. Print a record of user-defined alarm, supervisory, and trouble events on workstation printer.
   2. Sort and report by device name and by function.
   3. Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.
   4. Differentiate alarm signals from other indications.
   5. When system is reset, report reset event with same information concerning device, location, date, and time.
   6. User shall be able to report based on load types identified in paragraph 1.2 (B). Refer to Part 3 of this section for monitoring points and load types.

2.4 COMMUNICATION COMPONENTS AND NETWORKS
A. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, 100 Base-T Ethernet, and Modbus TCP/IP.

2.5 TIER 1 AND 2 POWER MONITORS
A. Separately mounted, permanently installed instrument for power monitoring and control, complying with UL 1244.
   1. Enclosure: NEMA 250, Type 1.

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

C. Tier 1 Service or Alternative Energy power monitors shall be rated for bi-directional power flow.

D. rms Real-Time Measurements:
   1. Current: Each phase, neutral, average of three phases, percent unbalance.
   2. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
   3. Power: Per phase and three-phase total.
   4. Reactive Power: Per phase and three-phase total.
   5. Apparent Power: Per phase and three-phase total.
   6. Power Factor: Per phase and three-phase total.
   7. Displacement Power Factor: Per phase and three-phase total.
8. Frequency.
9. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
10. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
11. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).

E. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:
   1. Present.
   2. Running average.
   3. Last completed interval.
   4. Peak.

F. Demand Real Power Calculations, Three-Phase Total:
   1. Present.
   2. Running average.
   3. Last completed interval.
   4. Predicted.
   5. Peak.
   6. Coincident with peak kVA demand.
   7. Coincident with kVAR demand.

G. Demand Reactive Power Calculations, Three-Phase Total:
   1. Present.
   2. Running average.
   3. Last completed interval.
   4. Predicted.
   5. Peak.
   6. Coincident with peak kVA demand.
   7. Coincident with kVAR demand.

H. Demand Apparent Power Calculations, Three-Phase Total:
   1. Present.
   2. Running average.
   3. Last completed interval.
   4. Predicted.
   5. Peak.
   6. Coincident with peak kVA demand.
   7. Coincident with kVAR demand.

I. Average Power Factor Calculations, Demand Coincident, Three-Phase Total:
   1. Last completed interval.
   2. Coincident with kW peak.
   3. Coincident with kVAR peak.
   4. Coincident with kVA peak.

J. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:
   1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
   2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
      a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
      b. Fixed block that calculates demand at end of the interval.
c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:
   a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
   b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
   c. Demand can be synchronized with clock in the power meter.

K. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:
   1. Line-to-line voltage.
   2. Line-to-neutral voltage.
   3. Current per phase.
   4. Line-to-line voltage unbalance.
   5. Line-to-neutral voltage unbalance.
   6. Power factor.
   7. Displacement power factor.
   8. Total power.
   9. Total reactive power.
  10. Total apparent power.
  11. Frequency.

L. Current and Voltage Ratings:
   1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
   2. Withstand ratings shall not be less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
   3. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.

M. Accuracy:
   1. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters. Accuracy from Light to Full Rating shall meet the following criteria:
      a. Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
      b. Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
      c. Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
      d. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.
   2. Current Transformer shall be solid core and rated for accuracy Class 0.2 or better as established by IEEE C57.13.
   3. Current Transformers shall have a minimum Thermal Current Rating Factor of 1.33.

N. Input: Two digital input signal(s).
   1. Normal mode for on/off signal.
   2. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
   3. Conditional energy signal to control conditional energy accumulation.

O. Outputs:
   1. Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.
   2. Closed in either a momentary or latched mode as defined by user.
3. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
4. One digital KY pulse to a user-definable increment of energy measurement. Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V rms isolation.
5. One relay output module(s), providing a load voltage range from 20- to 240-V ac or from 20- to 30-V dc, supporting a load current of 2 A.
6. Output Relay Control:
   a. Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
   b. Normally open and normally closed contacts, field configured to operate as follows:
      1) Normal contact closure where contacts change state for as long as signal exists.
      2) Latched mode when contacts change state on receipt of a pickup signal; changed state is held until a dropout signal is received.
      3) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
      4) End of power demand interval when relay operates as synchronization pulse for other devices.
      5) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
6) Output controlled by multiple alarms using Boolean-type logic.

P. Onboard Data Logging:
1. Store logged data, alarms, events, in 500MB of onboard nonvolatile memory.
2. Stored Data:
   a. Custom Data Logs: One user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:
      1) Schedule interval.
      2) Event definition.
      3) Configured as "fill-and-hold" or "circular, first-in first-out."
   b. Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
3. Default values for all logs shall be initially set at factory, with logging to begin on device power up.

Q. Alarms.
1. User Options:
   a. Define pickup, dropout, and delay.
   b. Assign one of four severity levels to make it easier for user to respond to the most important events first.
   c. Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.
2. Alarm Events:
   a. Over/undercurrent.
   b. Over/undervoltage.
   c. Current imbalance.
   d. Phase loss, current.
   e. Phase loss, voltage.
   f. Voltage imbalance.
   g. Over kW demand.
   h. Phase reversal.
   i. Digital input off/on.

R. Control Power: 90- to 457-V ac or 100- to 300-V dc.
S. Communications:
   1. Power monitor shall be permanently connected to communicate via a serial RS-485 Modbus connection to the BAS Building Control cabinet.
   2. Modbus TCP via a 100 Base-T Ethernet connection shall be available.
   3. Local plug-in connections shall be for RS-232.

T. Display Monitor:
   1. Backlighted LCD to display metered data with touch-screen or touch-pad selecting device.
   2. Touch-screen display shall be a minimum 12-inch diagonal, resolution of 800 by 600 RGB pixels, 256 colors; NEMA 250, Type 1 display enclosure.
   3. Display four values on one screen at same time.
   4. Reset: Allow reset of the following parameters at the display:
      a. Peak demand current.
      b. Peak demand power (kW) and peak demand apparent power (kVA).
      c. Energy (MWh) and reactive energy (MVARh).

2.6 TIER 3- STANDALONE, WEB-ENABLED MONITORING AND CONTROL INSTRUMENT (MULTI-CHANNEL SUBMETERING DATA RECORDER)

A. Separately mounted, permanently installed instrument for power monitoring and control.
   1. Enclosure: NEMA 250, Type 1.

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability.
   1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

C. Sub-metering channels: Shall be capable of monitoring a minimum of 42 single-phase branch circuit current inputs and panelboard mains and neutral.

D. Branch Circuit Level Accuracy:
   1. Accuracy from Light to Full Rating shall meet the following criteria:
      a. Power: Accurate to 3 percent of reading.
      b. Voltage and Current: Accurate to 1 percent of reading from 2.0-100A.
   2. Current Transformer shall be split core and rated for accuracy of 0.5% or better.

E. Panelboard Mains or Sub-Main Accuracy:
   1. Voltage: Accurate to 1% of reading from 90-277V line to Neutral.
   2. Current: Accurate to 2% of reading from 1-10%, 1% of reading from 10-100%.

F. Measured values for branch circuit level monitoring:
   1. Current
   2. Maximum current
   3. Current demand
   4. Real power (kW)
   5. Real Power (kW) demand
   6. Energy (kWh)
   7. Power factor

G. Measured values for main and sub-main level monitoring:
   1. Current per phase
   2. Max current per phase
   3. Current demand per phase
   4. Energy (kWh) per phase
5. Real power (kW) per phase
6. Power Factor Total based on three phase breaker rotation
7. Power factor per phase
8. Voltage Line-to-Line rms
9. Voltage Line-to-Neutral rms
10. Frequency from single phase.

H. Power-Distribution Equipment Monitor: Web enabled, with integral network port and embedded Web server with factory-configured firmware and HTML-formatted Web pages for viewing of power monitoring and equipment status information from connected devices equipped with digital communication ports.

I. LAN Connectivity: Multipoint, RS-485 Modbus serial communication network, interconnecting all metering devices equipped with communications. Serial communication network connected to Ethernet server that functions as a gateway and server, providing data access via 100 Base-T LAN.

J. Communication Devices within the Equipment: Addressed at factory and tested to verify reliable communication with network server.

K. Server Configuration:
   1. Initial network parameters set using a standard Web browser. Connect via a local operator interface, or an RJ-45 port accessible from front of equipment.
   2. Network server shall be factory programmed with embedded HTML-formatted Web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of RS-485 network; with internal memory management information pages for viewing using a standard Web browser.
   3. Login: Password protected; password administration accessible from the LAN using a standard Web browser.
   4. Operating Software: Suitable for local access; firewall protected.

L. Data Access:
   1. Network server shall include embedded HTML pages providing real-time information from devices connected to RS-485 network ports via a standard Web browser.

M. Equipment Monitoring Options: Login shall be followed by a main menu for selecting summary Web pages that follow.

N. Summary Web pages shall be factory configured to display the following information for each communicating device within the power equipment lineup:
   1. User-Configured Custom Home Page: Provide for the lineup, showing status-at-a-glance of the following key operating values:
      a. Mechanical Branch Circuit Loads
      b. Plug Loads
      c. Lighting Loads
   2. Circuit Summary Page: Circuit name, three-phase average rms current, power (kW), power factor.
   3. Load Current Summary Page: Circuit name, Phase A, B, and C rms current values.
   4. Demand Current Summary Page: Circuit name, Phase A, B, and C average demand current values.
   5. Power Summary Page: Circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
   6. Energy Summary Page: Circuit name, energy (kWh), reactive energy (kVARh), and time/date of last reset.

O. Communications:
1. Power monitor: Permanently connected to communicate via RS-485 Modbus TCP/IP or Modbus TCP via a 100 Base-T Ethernet.

2.7 LAN CABLES
A. Comply with Section 271000 "Structure Cabling."
B. RS-485 Cable:
   1. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
   2. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP.
C. Unshielded Twisted Pair Cables: Category 6 as specified for horizontal cable for data service in Section 271000 "Structure Cabling."

2.8 LOW-VOLTAGE WIRING
A. Comply with Section 260519 "Low-Voltage Electrical Power Conductors."
B. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
   1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
   2. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
   3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION
A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CABLING
A. Comply with NECA 1.
B. Install cables and wiring according to requirements in Section 271000 "Structure Cabling."
C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
D. Install LAN cables using techniques, practices, and methods that are consistent with specified category rating of components and that ensure specified category performance of completed and linked signal paths, end to end.
E. Install cables without damaging conductors, shield, or jacket.

3.3 IDENTIFICATION
A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
B. Label each power monitoring and control module with a unique designation.

3.4 GROUNDING
A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

3.5 LOAD TYPES MEASUREMENT AND VERIFICATION PERFORMANCE REPORTING
A. The power monitoring system shall monitor load measurements and verification requirements on a continual basis. Provide all necessary interfaces to make these values available to the system at all times.
B. It is the responsibility of the contractor and manufacturer of the power monitoring system to assign and identify the power monitors and associated load type. Refer to drawings and panelboard schedules for identification of the load types.
C. Assign branch circuit monitoring load types based on the load description in the panelboard schedule.
D. The contractor shall be responsible for coordinating final branch circuit assignments and identifying which load category they belong to, and providing this information to the BAS programmer.

3.6 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
B. Tests and Inspections:
   1. Electrical Tests: Use caution when testing devices containing solid-state components.
   2. Continuity tests of circuits.
   3. Operational Tests: Work with the Div. 23 contractor to set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.
      a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
      b. Test LANs according to requirements in Section 271000 "Structure Cabling."
      c. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
      d. Verify accuracy of graphic screens and icons.
      e. Metering Test: Load feeders, measure loads on feeder/branch circuit conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
      f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer to the Engineer and the Client's Facilities Department.
C. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.
E. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

F. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

G. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

H. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain systems. See Section 017900 “Demonstration and Training.”

A. Provide a minimum of two 8 hours’ of training. One session is to be completed at or before Substantial completion. The second training session shall take place before Final Acceptance.

1. Include instructions on operation of the meter equipment, normal testing, adjustments to the meter, and use of the software maintenance tools provided.

2. Train them on how to change and assign load types to monitoring points.

3. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

3.8 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within 12 months from Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to 8 visits to Project during other-than-normal occupancy hours for this purpose.

3.9 SPECIFICATION PERFORMANCE SPREAD SHEET

A. Prepare a line by line comparison of this specifications and identify if the products or services offered are in compliance with the requirements of this specification. Identify any variations and proposed solutions or comparable products.

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<th>Compliance</th>
<th>Variation</th>
<th>Submittal Reference</th>
<th>Comments</th>
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SECTION 260923
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Standalone daylight-harvesting switching and dimming controls.
   2. Indoor occupancy and vacancy sensors.
   4. Wall dimmer occupancy sensors.
   5. Digital timer light switches.
   6. High-bay occupancy sensors.
   7. Wall-box dimmers.

B. Related Requirements:
   1. Section 260523 "Control-Voltage Electrical Power Cables: For control cable requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Show installation details for the following:
      a. Occupancy sensors.
      b. Vacancy sensors.
   2. Interconnection diagrams showing field-installed wiring.
   3. Include diagrams for power, signal, and control wiring.
   4. Provide coversheet indicating project title, project location, and vendor contact information.
   5. Organize submittal into logical sections and provide table of contents.
   6. Provide itemized bill of materials indicating model number and quantity for each product.
   7. On datasheets with multiple products, indicate which product is provided under this project.
   8. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   9. Manufacturers' catalog sheets with complete technical data for each item being furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's warranties.

C. Refer to Section 018113 "Sustainable Design Requirements" for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.
1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On manufacturer’s website. Provide names, versions, and website addresses for locations of installed software.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.6 WARRANTY
A. Manufacturer’s Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of lighting control software.
      b. Faulty operation of lighting control devices.
   2. Warranty Period: Two year(s) from date of Substantial Completion.

1.7 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 PRODUCTS

2.1 DAYLIGHT-HARVESTING DIMMING CONTROLS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper Industries, Inc.
   2. Hubbell Building Automation, Inc.
   4. Lithonia Lighting; Acuity Lighting Group, Inc.
   5. Watt Stopper.

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
   1. Lighting control set point is based on two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools.
      a. Initial setup tool.
      b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated power pack, to detect changes in indoor lighting levels that are perceived by the eye.

D. Electrical Components, Devices, and Accessories:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

E. Power Pack: Digital controller capable of accepting 3 RJ45 inputs with two outputs rated for 20-A ballast load at 120- and 277-V ac, for 16-A LED at 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc class 2 power source, as defined by NFPA 70.
   1. With integral current monitoring
      a. compatible with digital addressable lighting interface.
      1) Plenum rated.

2.2 INDOOR OCCUPANCY AND VACANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Bryant Electric; a Hubbell company.
   2. Cooper Industries, Inc.
   3. Hubbell Building Automation, Inc.
   5. Lithonia Lighting; Acuity Lighting Group, Inc.
   7. NSi Industries LLC; TORK Products.
   8. Philips Lighting Controls
   9. RAB Lighting.
  10. Sensor Switch, Inc.
  11. Square D; a brand of Schneider Electric.
  12. Watt Stopper.

A. General Requirements for Sensors:
   2. Dual technology.
   3. Integrated power pack.
   4. Hardwired connection to switch and capability to interface with BAS and lighting control system.
   5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   6. Operation:
      a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
      b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
      c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
   9. Power Pack: Dry contacts rated for 20-A ballast or LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
   10. Mounting:
       a. Sensor: Suitable for mounting in any position on a standard outlet box.
       b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

B. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches (305 mm).
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches (305 mm).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet (110 square meters) when mounted 48 inches (1200 mm) above finished floor.

2.3 SWITCHBOX-MOUNTED OCCUPANCY AND VACANCY SENSORS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Bryant Electric; a Hubbell company.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Intermatic, Inc.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Co., Inc.
8. NSI Industries LLC; TORK Products.
9. Philips Lighting Controls
10. RAB Lighting.
11. Sensor Switch, Inc.
12. Square D; a brand of Schneider Electric.
13. Watt Stopper.
A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox, with provisions for connection to BAS.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
   4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA ballast or LED load at 277 V, and 800-W incandescent.
   5. Faceplate: Color matched to switch.
   6. Color: White

2.4 WALL DIMMER OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Lutron Maestro 0-10 V Dimmer Sensor Series or comparable product.

B. Description:
   1. 0-10V Wall Dimmer Occupancy Sensors:
      a. Compatible with sourcing electronic 0-10 V ballasts/drivers, as per IEC 60929 Annex E.2 0-10 V protocol.
      b. Adjustable sensitivity (high, medium, low, and minimum presets).
      c. Adjustable high/low end trims.
      d. Selectable dimming curve (linear or square law).
      e. Dimmer Features: Locked preset, fade-to-on, fade-to-off.
      f. Turns off lighting after reasonable and adjustable time delay once the last person to occupy the space vacates a room or area. Provide adjustable timeout settings of 1, 5, 15, and 30 minutes.
      g. Selectable option to enable low light feature (automatic-on when ambient light is below threshold). Ambient light threshold to be selectable as either adaptive utilizing occupant feedback (Lutron Smart Ambient Light Detection) or as fixed (high, medium, low, and minimum presets).
      h. Fades lights to off over period of 10 seconds to warn occupant of impending load turn-off.
      i. Provides visual alert for miswire and incompatible load.
   2. Passive Infrared 0-10 V Wall Dimmer Combination Occupancy/Vacancy Sensors:
      a. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
      b. 0-10 V control for 0-10 V fluorescent ballasts/LED drivers (8 A load at 120-277 V, 50 mA max control current).
      c. Coverage of 900 square feet (81 sq m) with mounting height of 4 feet (1.2 m).
      d. 180 degree field of view.
      e. Multi-location capability using standard 3-way or companion switch (up to nine companion switches may be connected).

2.5 DIGITAL TIMER LIGHT SWITCH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Industries, Inc.
   2. Hubbell Lighting.
   3. Intermatic, Inc.
   4. Invensys Controls
   6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Novitas, Inc.
8. NSi Industries LLC.
9. RAB Lighting, Inc.
10. Sensor Switch, Inc.
11. TE Connectivity Ltd.
12. TORK.
13. Watt Stopper (The).

B. Description: Combination digital timer and conventional switch lighting control unit, complying with UL 917. Switchbox-mounted, backlit LCD display, with selectable time interval in 10 minute increments.
   1. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 amps at 277-V ac for LED, and 1/4 horsepower at 120-V ac.
   2. Integral relay for connection to BAS.
   3. Voltage: Match the circuit voltage.
   5. Faceplate: Color matched to switch.

2.6 HIGH-BAY OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Hubbell Building Automation, Inc.

B. General Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
   3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
   5. Operating Ambient Conditions: 32 to 149 deg F (0 to 65 deg C).
   7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
   8. Detector Technology: PIR.
   9. Power and dimming control from the lighting fixture ballast that has been modified to include the dimming capacitor.

C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet (3.7 to 15.2 m).

D. Accessories: Obtain manufacturer’s installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.7 WALL-BOX DIMMERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bryant Electric; a Hubbell company.
   2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Intermatic, Inc.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC; TORK Products.
9. Philips Lighting Controls
10. RAB Lighting.
11. Sensor Switch, Inc.
12. Square D; a brand of Schneider Electric.
13. Watt Stopper.

B. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

C. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

D. Power Failure Recovery: When power is interrupted for periods up to 1 year and subsequently restored, lights to automatically return to same levels (dimmed setting, full on, or full off) as prior to power interruption.

E. Dimmers for Electronic Low Voltage (ELV) Transformers: Minimum of 90 percent of line voltage.

F. LED Lamp Dimmer Switches: Modular; compatible with dimming driver; dimmer-ballast combination capable of consistent dimming with low end not greater than 10 percent of full brightness
   1. Provide dimmer and driver that are compatible and tested to comply with UL standards.
   2. Continuous Flicker Free dimming range 100% to 1% measured relative light output.
   3. Meets FCC Part 15 Non-Consumer requirements for EMI/RFI emissions in a typical grounded fixture
   4. Provide dimmers with Pulse Width Modulation for both constant current or constant wattage drivers to maintain LED color when dimming, unless noted otherwise on the Luminaire Schedule.

2.8 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Lighting Control and Design; Acuity Lighting Group, Inc.
   2. Watt Stopper.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
   1. Coil Rating: 277 V.

2.9 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
PART 3 EXECUTION

3.1 EXAMINATION
A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION
A. Comply with NECA 1.
B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 WIRING INSTALLATION
A. Comply with NECA 1.
B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION
A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections
   1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 ADJUSTING
   A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
      1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
      2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
      3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 SOFTWARE SERVICE AGREEMENT
   A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

   B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
      1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION
   A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.03 “Distributed Digital Lighting Controls.”

   B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION
SECTION 260936
MODULAR DIMMING CONTROLS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Wall-box, multiscene, modular dimming controls.
   2. Multipreset modular dimming controls.

B. Related Requirements:
   2. Section 260523 “Control-Voltage Electrical Power Cables: For control cable requirements.

1.3 DEFINITIONS

A. BAS: Building automation system.
B. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
C. Low Voltage: As defined in NFPA 70, the term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.
D. RFI: Radio-frequency interference.
E. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
F. SCR: Silicon-controlled rectifier.
G. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a “channel.”

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. For modular dimming controls; include elevation, dimensions, features, characteristics, ratings, and labels.
   2. Device plates and plate color and material.
   4. Sound data including results of operational tests of central dimming controls.
   5. Operational documentation for software and firmware.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
   1. Include elevation views of front panels of control and indicating devices and control stations.
   2. Include diagrams for power, signal, and control wiring.
3. Address Drawing: Reflected ceiling plan and floor plans, showing connected luminaires, address for each luminaire, and luminaire groups. Base plans on construction plans, using the same legend, symbols, and schedules.

4. Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads. Include percentage of rated connected load and device addresses.

5. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.

6. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

7. Provide coversheet indicating project title, project location, and vendor contact information.

8. Organize submittal into logical sections and provide table of contents.

9. Provide itemized bill of materials indicating model number and quantity for each product.

10. On datasheets with multiple products, indicate which product is provided under this project.

11. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.

12. Manufacturers' catalog sheets with complete technical data for each item being furnished.

C. Samples for Verification: For master- and remote-control stations, and faceplates with factory-applied color finishes and technical features.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in Section 230900 "Instrumentation and Controls for HVAC."

1. Show interconnecting signal and control wiring, and interface devices that show compatibility of inputs and outputs.

2. For control interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For standalone multipreset modular dimming controls to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017800 "Closeout Submittals," include the following:
   a. Software manuals.
   b. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
   c. Operation of adjustable zone controls.
   d. Testing and adjusting of panic and emergency power features.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of standalone multipreset modular dimming controls that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Damage from transient voltage surges.
2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Douglas Lighting Controls.
3. Lightolier Controls; a Philips Group brand.
4. Lutron Electronics Co., Inc.
5. Philips Lighting Controls.

2.2 SYSTEM DESCRIPTION

A. Compatibility:

1. Dimming control components shall be compatible with luminaires, ballasts, and transformers.
2. Dimming control devices shall be compatible with lighting control system components specified in Section 260943.03 "Distributed Digital Lighting Controls," and in Section 260923 "Lighting Control Devices."

B. Dimmers and Dimmer Modules: Comply with UL 508.

1. Audible Noise and RFI Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or RFI. Modules shall include integral or external filters to suppress audible noise and RFI.
2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.

C. Capacities: Unit shall be rated for 2400 W at 240-V ac and 2000 W at 120-V ac for up to 100 devices or zones.

D. Surge Protection: Withstand supply power surges without impairment to performance.


E. Off Control Position: User-selected off position of any control point shall disconnect the load from line supply.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 WALL-BOX MULTISCENE DIMMING CONTROLS

A. Description: Factory-fabricated equipment providing manual dimming consisting of a wall-box-mounted master controller and indicated number of wall-box zone stations. Controls and dimmers shall be integrated for mounting in multigang wall box under a single wall plate. Each zone shall be adjustable to indicated number of scenes, which shall reside in the memory of zone controller.

B. Dimmers: Each zone shall be configurable to control the following loads:

1. LED lamps.
2. Incandescent lamps.
3. Low-voltage incandescent lamps, derived with electronic transformers.
4. Non-dim, on-off switching only.
C. Dimmers: Regulate voltages to maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent rms.

D. Memory:
   1. Retain preset scenes and fade rates through momentary (up to 3-second) power interruptions.
   2. Retain preset scenes through power failures for at least seven days.

E. Device Plates: Style, material, and color shall comply with Section 262726 "Wiring Devices." Master-control cover plate shall be one piece.

F. Master controller shall include the following:
   1. Cover-mounted switches, including master off, all bright, and selectors for each scene.
   2. Cover-mounted LED indicator lights, one associated with each scene switch, and one for the master off switch.
   3. Concealed switches and indicators for specified function.
   4. A raise/lower switch for each zone for temporary adjustments of the zone, without altering scene values stored in memory.
   5. Fade time indicated by digital display for current scene while fading.
   6. Cover-mounted infrared receiver.

2.4 CONDUCTORS AND CABLES
A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 2 0-10V Control Circuits Installed with Class 1 Conductors: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway

PART 3 EXECUTION
3.1 WIRING INSTALLATION
A. Comply with NECA 1.

B. Wiring Method: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 IDENTIFICATION
A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identifying components and power and control wiring.

B. Label each dimmer module with a unique designation.

C. Label each scene control button with approved scene description.
3.3 **FIELD QUALITY CONTROL**

A. **Testing Agency:** Engage a qualified testing agency to perform tests and inspections.

B. **Manufacturer's Field Service:** Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Continuity tests of circuits.
   2. **Operational Test:** Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
      a. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

D. Dimming control components will be considered defective if they do not pass tests and inspections.

E. **Test Labeling:** After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

F. **Reports:** Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.4 **DEMONSTRATION**

A. Owner's maintenance personnel to adjust, operate, and maintain modular dimming controls. Lap-top portable computer shall be used in training.

B. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Section 260943.03 "Distributed Digital Lighting Controls."

**END OF SECTION**
SECTION 260943.03
DISTRIBUTED DIGITAL LIGHTING CONTROLS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Provide Distributed Digital Lighting Controls (controls) as indicated on the drawings and as specified herein. The controls shall consist of a series of standalone digital load controllers and intelligent low-voltage devices dedicated to the room/space they are serving. All local devices shall be connected together via an In-Room Network, enabling digital communication between devices. Digital Lighting Control Panels, where indicated on the drawings, may also be used for lighting control as part of the overall lighting control scheme. Section Includes: Lighting control panels using mechanically held relays for switching.

B. The system architecture shall connect multiple In-Room local networks for centralized building-wide monitoring and management via a Global Network and PC-based software. Refer to the drawings for which rooms/spaces are to be connected to the Global Network. The system architecture shall allow standalone digital load controllers and associated devices to function in some default capacity, even if network connectivity to the Global Network is lost.

C. The controls shall provide time-based, sensor-based (e.g. occupancy/vacancy and daylight sensors), and/or manual control as indicated in the lighting sequences of operation on the drawings. The controls shall turn lighting loads ON/OFF, and shall dim the lighting where indicated.

D. Section Includes: Networked lighting control panels using control-voltage relays for switching and that are interoperable with HVAC DDC system.

1.3 RELATED SECTIONS
A. Section 260800 "Commissioning of Electrical".
B. Section 265119 "LED Interior Lighting".

1.4 REFERENCE STANDARDS
A. NFPA 70 National Electrical Code; National Fire Protection Association
B. NEMA National Electrical Manufacturers Association
C. FCC Federal Communications Commission – Emission Standards
D. UL Underwriters Laboratories, Inc. Listings
E. UL 2043 Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products Installed in Air-Handling Spaces
F. UL 20 General-Use Snap Switches
G. UL 508 Standard for Industrial Control Equipment
H. UL 916 Standard for Energy Management Equipment
I. UL 924 Standard for Emergency Lighting and Power Equipment
1.5 DESIGN/PERFORMANCE REQUIREMENTS

A. Distributed Digital Lighting Controls shall accommodate the square-footage coverage requirements for each area controlled utilizing digital load controllers, digital occupancy/vacancy sensors, digital daylighting sensors, digital switches, digital lighting control panels, and accessories that suit the required lighting and electrical system parameters.

B. System shall conform to requirements of NFPA 70.

C. System shall comply with FCC emission standards specified in part 15, sub-part J for commercial and residential application.

D. System shall be listed under UL sections 916 and/or 508.

1.6 DEFINITIONS

A. DDC: Direct digital control.

B. IP: Internet protocol.

C. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and plates, and conductors and cables.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   3. Sound data including results of operational tests of central dimming controls.
   4. Operational documentation for software and firmware.

B. Shop Drawings: For each relay panel and related equipment.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. All manufacturers shall submit to the specifying engineer a line-by-line compliance comparison between each specifications requirement and the system being proposed. Any ambiguities in the drawings or specifications shall be brought to the attention of the specifying engineer for clarification.
   8. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   9. Detail enclosure types and details for types other than NEMA 250, Type 1.
   10. Detail wiring partition configuration, current, and voltage ratings.
   11. Short-circuit current rating of relays.
   12. Address Drawing: Reflected ceiling plan and floor plans, showing connected luminaires, address for each luminaire, and luminaire groups. Base plans on construction plans, using the same legend, symbols, and schedules.
13. Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads. Include percentage of rated connected load and device addresses.
15. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

C. Refer to Section 018113 “Sustainable Design Requirements” for requirements of sealants, primers, paints, adhesives, caulks, aerosols, and coatings.

1.8 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Section 230900 "Instrumentation and Controls for HVAC."
   1. Show interconnecting signal and control wiring, and interface devices that prove compatibility of inputs and outputs.
   2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the network protocol.
B. Qualification Data: For testing agency.
C. Field quality-control reports.
D. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
E. Sample Warranty: For manufacturer’s special warranty.

1.9 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: Username and password for manufacturer’s support website.
   3. Device address list.
   4. Printout of software application and graphic screens.
   5. Testing and adjusting of panic and emergency power features.

1.10 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. One (1) ON/OFF Load Controller with three relays
   2. One (1) ON/OFF/Dimming Load Controller with three relays
   3. One (1) of each type of motion sensor used
   4. One (1) daylight sensor
   5. One (1) two-button digital wall switch
   6. One (1) four-button digital wall switch
   7. One (1) eight-button digital wall switch
1.11 QUALITY ASSURANCE
A. Testing Agency Qualifications: Accredited by NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
B. Example Contractor Startup/Commissioning Worksheet – must be completed prior to factory start-up

1.12 DELIVERY, STORAGE, AND HANDLING
A. Handle and prepare panels for installation according to NECA 407.

1.13 WARRANTY
A. Special Warranty: Manufacturer agrees to repair or replace components of standalone multipreset modular dimming controls that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Damage from transient voltage surges.
   2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS
A. Lighting control zones shall consist of one or more intelligent lighting control components (digital load controllers), be capable of stand-alone operation, and be capable of being connected to a higher-level network backbone.
B. Network Characteristics
   1. In-Room Network:
      a. The In-Room network shall be a free topology lighting control network using physical wiring connections and communication protocol designed to control a room/space/small area of a building.
      b. Digital room devices connect to the In-Room network, which provides both communications and power to room devices.
   2. Global Network (In-Room to In-Room Network):
      a. The Global network shall be a linear topology network to connect In-Room networks and relay panels (if applicable) for centralized control.
      b. Each In-Room Network to be connected to the Global Network shall include a single network bridge, and the network bridge is the only room-based device that is connected to the Global Network.
      c. The Global Network shall utilize communications cabling as specified by the manufacturer. The maximum cable run for each segment (distance between In-Room Networks) shall meet manufacturer limitations.
   3. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the Global Network or the management software becoming unavailable.
   4. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.
5. System shall be capable of using a web-based software management program that enables remote system control, status monitoring, and creation of lighting control schedules and profiles.

2.2 DIGITAL LOAD CONTROLLERS (ROOM CONTROLLERS)

A. General
   1. Digital load controllers shall be simple to install and shall not have dip switches or potentiometers, or require special configuration.
   2. The controllers shall include the following features:
      a. Standard junction box mounting.
      b. Low voltage connection using standard RJ-45 connectors and CAT5e cable. Other wiring topologies are acceptable if controls accomplish all requirements specified in these documents.
      c. Each connected load shall be capable of any of the following behaviors: Manual ON, Automatic ON, Automatic ON to 50 percent, or Automatic ON to Preset level or last level set.
      d. UL 2043 plenum rated.
      e. Manual override and LED indication for each load.
      f. Power supply to power the digital load controller itself and the peripheral sensors and controls connected to the In-Room Network.
      g. Dual voltage (120/277 VAC, 60 Hz), rated for 20A total load, derating to 16A required for some dimmed loads (forward phase dimming).
      h. Zero cross circuitry for each load.
      i. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

B. On/Off Load Controllers
   1. Controllers shall include the following:
      a. Multiple relay configurations per unit.

C. ON/OFF/Dimming Load Controllers
   1. Controllers shall include the following:
      a. Multiple relay configurations per unit.
      b. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected LED driver.
      c. One dimming output per relay.
         1) 0-10V Dimming: Where indicated, one 0-10 volt analog output per relay for control of compatible LED drivers. The 0-10 volt output shall automatically close upon loss of power to the Controller to assure full light output from the controlled lighting.
         2) Line Voltage, Forward Phase Dimming: Where indicated, one forward phase control line voltage dimming output per relay for control of compatible LED drivers, forward phase compatible ELV, and incandescent loads.
      d. Each load shall have an independently configurable preset ON level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.

2.3 DIGITAL MOTION SENSORS

A. General
   1. Sensors shall be available in wall, ceiling, corner-mounted, or wall-switch configurations.
   2. Sensors shall use either passive infrared (PIR) sensing, or if dual technology, passive infrared and passive acoustic or passive infrared and ultrasonic sensing for detecting room occupancy.
3. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas.

B. Features
   1. Sensors shall be provided with the following features:
      b. Dual-Technology Sensors shall have independent configurable trigger modes to choose proper technology according to space use to eliminate false-triggers.
      c. Each sensor may be programmed to control specific loads within an In-Room network.
      d. Each sensor shall allow remote programming through a handheld commissioning tool via a two-way infrared (IR) transceiver or by configuration through a local network device.

C. Digital Wall Switch Motion Sensors
   1. Digital wall switch motion sensors shall be provided with the following features:
      a. Shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.
      b. One- or two-button switches for one or two switch-legs.
      c. Optional daylight sensor feature for daylighting override.

2.4 DIGITAL DAYLIGHT SENSORS

A. Daylight sensors shall be provided with the following features:
   1. Digital daylighting sensors shall work with room controllers to provide automatic switching, bi-level, tri-level, or dimming daylight harvesting capabilities for any load type connected to a room controller.
   2. Daylighting sensors shall be interchangeable without the need for rewiring.
   3. Sensor light level range shall be from 1-250 foot-candles (fc).
   4. For switching daylight harvesting, the daylight sensor shall provide a field-selectable deadband (separation) between the “ON” setpoint and the “OFF” setpoint that will prevent the lights from cycling excessively after they turn OFF.
   5. For dimming daylight harvesting, the daylight sensor shall provide the option, when the daylight contribution is sufficient, of turning lights OFF or dimming lights to a field-selectable minimum level.
   6. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
   7. Daylight sensors shall have an independently configurable fade rate for both increasing and decreasing light level in units of percent-per-second.
   8. Daylight Sensors shall provide adjustable cut-off time (0-120 minutes). Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off.
   9. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
   10. Each sensor shall allow remote programming through a handheld commissioning tool via a two-way infrared (IR) transceiver or by configuration through a local network device.

2.5 DIGITAL MANUAL CONTROLS

A. Wall Switches
   1. Low voltage dimming and momentary pushbutton switches in 1, 2, 3, 4, 5, and 8 Button configurations.
   2. Wall switches shall include the following features:
      a. Buttons may be programmed as Load or Scene Buttons.
      b. Buttons may be programmed as ON/OFF, ON only, or OFF only.
      c. Switch buttons may be bound to any load on a room controller and are not load type dependent.
B. Dimmer Switches
   1. Raise/lower dimming adjustment controls.
   2. Dimmer switches shall include multiple LEDs to indicate load levels.
   3. Dimmer switches shall be able to be ganged with multi-button switches under the same wall-plate.
   4. Three-way and 4-way switch locations are supported for ON/OFF or Dimming control.
C. Digital Scene Switches
   1. Scene switches allow for Preset Scene recall and dimming override control.
D. Touch Panel Controls
   1. Touch Panel Controls are allowed, but not required. Touch Panel Controls are used for adjusting lighting and to set up and control preset lighting scenes in the associated room/space.
   2. Touch panel controls shall be provided with the following features:
      a. Full-color multi-touch capacitive touchscreen for controlling lighting and system components
      b. Control up to 16 dynamic lighting zones/scenes per touch screen or acting as up to 16 ON/OFF/DIM control switches
      c. Lighting zones/scenes can be comprised of lighting intensity, color, color temperature, and luminaire position
      d. Modify color and color temperature using a digital color palette and UV rating scale
      e. Proximity screen sensor for auto "wake-up"
      f. Auto dimming and user adjustable backlight
      g. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens. User programmable screen lock limiting access to all feature controls and programming
      h. Full alpha-numeric scene and zone naming
      i. Configurable interface to reflect project requirements
      j. Lighting zones/scenes support control of forward/reverse phase dimming, 0-10V, RGB, tunable white, and moving fixtures
      k. Integral astronomical time clock enables lighting scenes
      l. Partition status control and visualization
      m. Direct DMX control
      n. Digital motion sensor control
      o. Digital daylight harvesting response
      p. Shall have the ability to control connected load through time schedules.
      q. RS-232/contact closure capable for 3rd party integration
      r. Local wireless Bluetooth connectivity with mobile app
      s. Device shall have a micro-USB style connector for local computer connectivity.
      t. Remote-mounted power supply

2.6 DIGITAL LED LUMINAIRES
A. Digital LED luminaires are allowed, but not required.
B. Digital LED Luminaires with are luminaires with embedded controls (a.k.a. "enabled" luminaires). Enabled luminaires to have a mechanically-integrated control device, allowing the luminaires to communicate digitally with other digital lighting controls. All lighting control devices and “enabled” luminaires within a controlled room/space shall be networked together, enabling digital communication between devices.

2.7 DIGITAL AUXILIARY INPUT/OUTPUT (I/O) INTERFACE MODULES
A. General
1. Operate on Class 2 power supplied by In-Room network.
2. Status LEDs indicate if input is energized.
3. UL 2043 plenum rated where required.

B. Switched Contact Closure Interface
1. Utilized for automatic control via input from other sources such as switches, relay-based system
2. Includes 24VDC output and input terminals for momentary or maintained third party contact closure inputs.
3. Utilize input module for an Auto ON and Sweep OFF function input from other sources for the controlled area. During normal hours of operation, all local low-voltage devices are fully operational. During after hours, a timer shall be applied to all low-voltage switches or dimmers so that the room will automatically sweep off every two hours following switch activation. Provide a blink warning to alert occupants of impending OFF.
4. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current.
5. Specific I/O devices shall have an input that reads a 0-10 VDC signal from an external device.
6. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event (e.g. toggle the lighting load) or run a local/remote control profile.
7. Specific I/O devices shall sense state of low-voltage outdoor photocells.
8. Specific I/O devices shall sense momentary and maintained contact closures, and either toggle a connected load after a momentary contact or ramp the load high/low during a maintained contact (stopping when the contact releases).

C. Serial Data Interface
1. Utilized for control from A/V system to send ON/OFF/Preset commands to In-Room Network.
2. Includes 24VDC output and 10 pin RS232 connection.
3. Coordinate programming with the Distributed Digital Lighting Control System manufacturer’s technician and the A/V system technician for successful interface between both systems.

2.8 DIGITAL LIGHTING CONTROL PANELS (RELAY AND DIMMING PANELS)

A. General
1. It is the intent of this paragraph to provide a Digital Lighting Control Panel as part of an integrated lighting control system. Contractor is responsible for confirming that the panels and associated peripheral devices such as sensors and manual controls interoperate as a single system.
2. Digital Lighting Control Panels shall be incorporated into the lighting control system Global Network where used.
3. Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:
   a. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
   b. The interior construction shall provide total isolation of line voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel.
   c. Direct wired switch inputs associated with each relay shall support two-wire, momentary or maintained contact switches.
   d. Digital inputs shall support digital switches, digital I/O modules capable of receiving 0-5V or 0-10V analog photocell inputs, digital I/O modules capable of receiving momentary or maintained contact closure inputs, digital photocell modules, and digital occupancy sensors.
e. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells associated with the lighting control panel as necessary to meet the project requirements.

B. Relays
1. Relays shall provide the following ratings and features:
   a. Panel shall provide one 0-10VDC dimming output paired with each relay.
   b. Each relay shall contain an LED status light and an override pushbutton. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
   c. Relays shall be individually replaceable in a modular plug-in design.
   d. Relays shall be single-phase normally-closed latching type relays capable of switching 120/277 VAC or two-phase relays capable of switching 208/240/480 VAC loads.
   e. Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
   f. Tested to 300,000 mechanical on/off cycles.
   g. Relay operation shall be automatically sequenced to reduce impact on the electrical distribution system when large loads are controlled simultaneously.

C. Digital Network Clock
1. Each panel shall include a digital clock capable to issue system wide automation commands.
2. The clock module shall provide astronomical capabilities, time delays, blink warning, daylight savings, and holiday functions and shall include battery backup for the clock function and for program retention. The clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
3. The clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours to automation groups that implement pre-configured control scenarios. Scenarios shall include:
   a. Scheduled ON / OFF
   b. Manual ON / Scheduled OFF
   c. Astro ON / OFF (or Photo ON / OFF)
   d. Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
4. Schedules programmed into the clock of any one panel shall be capable of executing local schedules or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost.

2.9 CONFIGURATION TOOLS
A. A configuration tool facilitates optional customization of In-Room networks.
   1. Provide two Configuration Tools for the project.
   2. Provide free, downloadable PC software for direct programming of In-Room Networks.

B. Features and functionality of the wireless configuration tool shall include but not be limited to:
   1. Optional customization of In-Room networks using two-way wireless communications or USB interface.
   2. Must be able to read and modify parameters for room controllers, occupancy sensors, wall switches, daylighting sensors, network bridges and relay panels, and identify room devices by type and serial number.
   3. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.

2.10 NETWORK CABLES
A. In-Room Networks
1. This specification is based on CAT5e data cables for In-Room Networks. Other wiring topologies are acceptable if controls accomplish all requirements specified in these documents.

2. Use manufacturer’s factory-tested Cat 5e cable with pre-terminated RJ-45 connectors for In-Room Networks. If manufacturer’s cables are not used, each field-terminated cable shall be tested prior to installation and testing results submitted to the Manufacturer’s Representative for approval prior to proceeding with the Work.

3. UL 2043 plenum rated where required.

B. Global Network

1. The Global Network, where used, shall utilize communications cabling as specified by the manufacturer. The maximum cable run for each segment (distance between In-Room Networks) shall meet manufacturer limitations.

C. Class 2 0-10V Control Circuits Installed with Class 1 Conductors: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway

2.11 NETWORK INTERFACES

A. Global Network Bridge:

1. Provide one bridge for each In-Room Network that is to be connected to the Global Network.

2. UL 2043 plenum rated where required.

3. Manufacturer-specified network cable shall daisy-chain all network bridges together.

4. The Global Network Bridge module connects an In-Room Network to a segment of the Global Network for communication between rooms, relay panels, and a Global Management Controller.

5. The Global Network Bridge shall be provided as a separate module connected on the In-Room network.

6. Global Network Bridge shall make all room devices connected to the In-Room network and all device parameters visible to the Global Management Controller via the Global Network.

7. The global network bridge shall link back to front-end controller for connection to building LAN for centralized programming.

8. If a network bridge loses communication with the Global Network, In-room network shall stay active and operate as normally programmed. There shall be no disruption to local control.

B. Global Management Controller:

1. For networked applications, the system shall include at least one Global Management Controller to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP or encrypted SSL TCP/IP traffic via a configurable port.

2. Each Global Management Controller shall have integral support for at least three segments of the Global Network. Each segment may alternately be connected to the Global Management Controller via external routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment of the Global Network.

C. Operational features of the Controller shall include the following:

1. Connection to PC or LAN via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.

2. Graphical user interface shall be compatible with current internet browsers, and shall not require installation of any lighting control software on an end-user PC.

3. Log-in security capable of restricting some users to view-only or other limited operations.

4. Ability to view and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after-hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.
5. Ability to set up schedules for rooms and panels, view and override current status of panel channels and relays, and assign relays to groups. Schedules shall automatically set controlled zones or areas to either a normal-hours or after-hours mode of operation. Support for a minimum of 100 unique schedules, each with up to four time events per day. Support for annual schedules, holiday schedules and unique date-bound schedules.

6. Ability to group rooms and loads for common control by schedules, switches, or network commands.

D. Network Equipment
   1. Provide all necessary network components, i.e. routers, switches, repeaters, etc. as suggested by the manufacturer for a complete Global Network System.
   2. Global Network cables shall be furnished and installed by this contractor per manufacturer requirements.

E. Management Software
   1. Every device parameter (e.g. sensor time delay and photocell setpoint) shall be available and configurable remotely from the software.
   2. Software shall require all users to log in with a User Name and Password.
   3. Software shall provide at least three permission levels for users.
   4. All sensitive stored information and privileged communication by the software shall be encrypted.
   5. All device firmware and system software updates must be available for automatic download and installation via the internet.
   6. Software shall be capable of managing systems interconnected via a WAN (wide area network).

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING
   A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

3.2 PROJECT CONDITIONS
   A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer. Do not install products under environmental conditions outside manufacturer's absolute limits.
   B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
      1. Ambient temperature: 32 to 104 degrees F (0 to 40 degrees C).
      2. Relative humidity: Maximum 90 percent, non-condensing.

3.3 SENSOR LAYOUTS
   A. Confirm quantity and provide appropriate coverage by sensors on a per-space requirement. Symbols on drawings are diagrammatic and represent design intent only.
   B. Occupancy sensors shall be installed at locations indicated on the manufacturer’s submittal layout drawings. Sensors shall be located to prevent false triggering of the lights to ON when no occupant is present.
3.4 INSTALLATION

A. Install system in accordance with the approved system shop drawings and manufacturer's instructions.

B. Install all room/space devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors.
   1. If pre-terminated cable is not used for room/space wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer’s Representative for approval prior to proceeding with the Work.
   2. Install all room-to-room digital devices using manufacturer-supplied network wire. Network wire substitution is not permitted and may result in loss of product warranty.
   3. Low-voltage wiring topology must comply with manufacturer's specifications.
   4. Document final wiring locations, routing, and topology on as-built drawings.

C. All line-voltage connections shall be tagged to indicate circuit and switched legs.

D. Test all devices to ensure proper communication.

E. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.

F. Adjust time delay so that controlled area remains lighted while occupied.

G. Provide written or computer-generated documentation on the configuration of the system including room-by-room description including:
   1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
   2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
   3. Load Parameters (e.g. blink warning, etc.)

H. Tighten all panel Class I conductors at circuit breakers and at loads to torque ratings as marked on enclosure UL label.

I. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.

J. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimmed loads shall have separate neutrals.

K. Verify all loads to be free from short circuits prior to connection to room controllers.

3.5 FIELD QUALITY CONTROL

A. Electrician/Low Voltage Technician: Any low voltage wiring made onsite by electrical or low voltage contractor must be verified end to end with industry standard test equipment capable of printing or producing a digital file of the testing results.

B. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Notify Manufacturer in writing a minimum of three (3) weeks prior to system start-up and testing.

C. Tests and Inspections: Manufacturer’s service representative or electrical/low-voltage contractor installing low voltage cabling that is not pre-terminated from the manufacturer shall perform the following inspections and prepare reports:

D. Tests and Inspections: Manufacturer’s service representative shall perform the following inspections and prepare reports:
   1. Verify end-to-end testing of all low voltage wiring that is not pre-terminated from the manufacturer. Provide detailed results via paper or digital format downloadable from testing equipment.
2. Verify Class I and II wiring connections by validating system performance.
3. Set IP addresses and other network settings of system front-end hardware per facility’s IT instructions.
4. Verify/complete task programming for all switches, dimmers, time clocks, and sensors.
5. Verify that the control of each space complies with the Lighting Sequence of Operation.
6. Correct any system issues and retest.

E. Provide a report in table format with drawings, or using a software file that can be opened in the manufacturer’s system software including each room or space that has lighting control installed. Indicate the following:
   1. Date of test or inspection.
   2. Loads per space.
   3. Fixture Address identification.
   4. Quantity and Type of each device installed.
   5. Reports providing each device's settings.

3.6 POST START-UP TUNING
A. Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from initial occupancy. Provide a detailed report to the Architect/Owner of post start-up activity.

3.7 WARRANTY
A. Manufacturer shall provide a 5-year limited warranty on products within this installation, except where otherwise noted, and consisting of a one-for-one device replacement.

3.8 PRODUCT SUPPORT AND SERVICE
A. Factory telephone support shall be available at no cost to the Owner following acceptance. Factory assistance shall consist of assistance in solving application issues pertaining to the control equipment.

3.9 CONSTRUCTION VERIFICATION ITEMS
A. Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 260800 "Commissioning of Electrical".

3.10 AGENCY TRAINING
A. All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 017800 "Closeout Submittals".
B. The Contractor, through their supplier, shall provide training on the system operation for the owner as part of this contract. The training shall consist of two (2) four-hour sessions.

3.11 CYBERSECURITY RISK MITIGATION
A. Refer to specification section 013100, "Project Management and Coordination" for cybersecurity risk mitigation strategy.
B. Coordinate with Owner’s IT Department to restrict external network access to Internet connected system through virtual private network (VPN) connections only.
C. Disable any protocols for remote connectivity, unless constantly required for day-to-day operations.
D. All external transport data shall be routed through encrypted channels with 2048-bit secure sockets layer (SSL).
D. Coordinate with Owner’s IT Department to implement a Web server-based human machine interface (HMI) that relies on IT technologies to secure access and restrict ports that can be opened on the firewall. Coordinate with Owner’s IT Department to restrict access to known IP addresses only.

E. Where building system networks are not physically separate from IT business networks, coordinate with Owner’s IT Department to segregate networked and Internet connected systems from the IT business network using virtual local area network (VLAN) IT technologies to restrict internal attacks/breakdowns.

F. Set unique, cryptographically strong passwords for administrator and user accounts. Default passwords must be changed before systems are connected to the Owner’s network.

G. Collect only the data that is necessary for analytics and optimization.

H. References:
   4. IEC 62443: Industrial Network and System Security

END OF SECTION
SECTION 262213
LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
      2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

   B. Shop Drawings:
      1. Provide coversheet indicating project title, project location, and vendor contact information.
      2. Organize submittal into logical sections and provide table of contents.
      3. Provide itemized bill of materials indicating model number and quantity for each product.
      4. On datasheets with multiple products, indicate which product is provided under this project.
      5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
      6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
      7. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      8. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
      9. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For testing agency.
   B. Source quality-control reports.
   C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
   A. Testing Agency Qualifications: Accredited by NETA.
1. Testing Agency’s Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
   1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer’s packaging.
B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.
C. Temporary Heating: Apply temporary heat according to manufacturer’s written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
D. Handling: Follow manufacturer’s instructions for lifting and transporting transformers.

1.8 COORDINATION
A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ACME Electric Corporation; Power Distribution Products Division.
   2. Dongan Electric Manufacturing
   4. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
   5. General Electric Company.
   7. Marcus Transformer LTD
   8. MGM Transformer Company
   9. Micron Industries Corporation
   10. Mirus International Inc.
   12. Square D Co/Groupe Schneider NA; Schneider Electric.
B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS
A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
B. Comply with NFPA 70.
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
C. Transformers Rated 15 kVA and Larger:
1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
   1. One leg per phase.
   2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
   3. Grounded to enclosure.

C. Coils: Continuous windings except for taps.
   1. Coil Material: Copper.
   2. Internal Coil Connections: Brazed or pressure type.
   3. Terminal Connections: Bolted.

D. Enclosure: Ventilated.
   1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.
   2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
   3. Wiring Compartment: Sized for conduit entry and wiring installation.
   4. Finish: Comply with NEMA 250.
      a. Finish Color: Gray weather-resistant enamel.

E. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

H. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with DOE 2016 Amended Energy Conservation Standard for Low-Voltage Dry-Type Distribution Transformers, efficiency levels.
      a. 15 kVA: 97.89% efficiency
      b. 30 kVA: 98.27% efficiency
      c. 45 kVA: 98.40% efficiency
      d. 75 kVA: 98.60% efficiency
      e. 112.5 kVA: 98.74% efficiency
      f. 150 kVA: 98.83% efficiency
      g. 225 kVA: 98.94% efficiency
      h. 300 kVA: 99.02% efficiency
      i. 500 kVA: 99.14% efficiency
K. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
   1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
   2. Indicate value of K-factor on transformer nameplate.
   3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.

M. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
   1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
   2. Include special terminal for grounding the shield.

N. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

O. Wall Brackets: Manufacturer's standard brackets.

P. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
   1. 9.00 kVA and Less: 40 dBA.
   2. 9.01 to 30.00 kVA: 45 dBA.
   3. 30.01 to 50.00 kVA: 48 dBA for K-factors of 13 dBA.
   4. 50.01 to 150.00 kVA: 53 dBA for K-factors of 13 dBA.
   5. 150.01 to 300.00 kVA: 58 dBA for K-factors of 13 dBA.

2.4 IDENTIFICATION

A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
   1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
   2. Ratio tests at rated voltage connections and at all tap connections.
   3. Phase relation and polarity tests at rated voltage connections.
   4. No load losses, and excitation current and rated voltage at rated voltage connections.
   5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
   6. Applied and induced tensile tests.
   7. Regulation and efficiency at rated load and voltage.
   8. Insulation-Resistance Tests:
      a. High-voltage to ground.
      b. Low-voltage to ground.
      c. High-voltage to low-voltage.
   9. Temperature tests.

B. Factory Sound-Level Tests: Conduct prototype sound-level tests on production-line products.
PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
   1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
   2. Install neoprene pads for mounting.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

G. Do not install any transformer rated 50 KVA or larger above a lay-in acoustic tile ceiling.

H. Do not install any transformers above lay-in acoustic tile ceilings where the space above the ceiling is serving as an air handling plenum. Do not install transformers above any other type ceilings under any circumstances.

I. Suspend hanging transformers with a trapeze of unistrut or angle iron and threaded rod and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
   1. Install neoprene pads for mounting.

J. Provide a local enclosed circuit breaker overcurrent device/disconnect for all transformers not located within sight of primary feeder breaker. Size to be same as upstream overcurrent device.
3.3 CONNECTIONS
A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Perform tests and inspections with the assistance of a factory-authorized service representative.
C. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
   1. Visual and Mechanical Inspection.
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, and grounding.
      c. Verify that resilient mounts are free and that any shipping brackets have been removed.
      d. Verify the unit is clean.
      e. Perform specific inspections and mechanical tests recommended by manufacturer.
      f. Verify that as-left tap connections are as specified.
      g. Verify the presence of surge arresters and that their ratings are as specified.
   2. Electrical Tests:
      a. Measure resistance at each winding, tap, and bolted connection.
      b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
      c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
      d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
D. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, and grounding.
      c. Verify that resilient mounts are free and that any shipping brackets have been removed.
      d. Verify the unit is clean.
      e. Perform specific inspections and mechanical tests recommended by manufacturer.
      f. Verify that as-left tap connections are as specified.
      g. Verify the presence of surge arresters and that their ratings are as specified.
   2. Electrical Tests:
      a. Measure resistance at each winding, tap, and bolted connection.
b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.

c. Perform power-factor or dissipation-factor tests on all windings.

d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.

e. Perform an excitation-current test on each phase.

f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.

g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

E. Remove and replace units that do not pass tests or inspections and retest as specified above.

F. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.

3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION
PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Service and distribution switchboards rated 600 V and less.
   2. Surge protection devices.
   3. Disconnecting and overcurrent protective devices.
   4. Instrumentation.
   5. Control power.
   6. Accessory components and features.
   7. Identification.
   8. Mimic bus.

1.3 REFERENCES
A. Latest Edition of Referenced Standards:
   1. National Electrical Contractors Association (NECA):
      a. “Standard of Installation”.
   2. National Electrical Manufacturers Association (NEMA):
      a. AB 1 – Molded Case Circuit Breakers, Molded Case Switches and Circuit Breaker enclosures.
      b. PB 2 - Deadfront Distribution Switchboards.
      c. 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
      a. 70 - National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL):
      a. UL 489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures.
      b. UL 891 - Deadfront Switchboard.
      c. UL 1066 – Low Voltage Power Circuit Breakers

1.4 RELATED SECTIONS
A. Section 260574 "Overcurrent Protective Device Arc-Flash Study" for arc-flash study and arc-flash label requirements.

1.5 ACTION SUBMITTALS
A. Product Data: For each type of switchboard, overcurrent protective device, Surge Protective Device SPD (formerly transient voltage suppression device or TVSS), ground-fault protection per NEC 230.95, accessory, and component.
   1. Include dimensions and manufacturers’ technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
B. Shop Drawings: For each switchboard and related equipment.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
2. Organize submittal into logical sections and provide table of contents.
3. Provide itemized bill of materials indicating model number and quantity for each product.
4. On datasheets with multiple products, indicate which product is provided under this project.
5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
7. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
8. Detail enclosure types for types other than NEMA 250, Type 1.
9. Detail bus configuration, current, and voltage ratings.
11. Detail Infrared window locations and dimensions.
12. Identify IR window transmission levels for short wave and long wave transmittance.
13. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
14. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
15. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.
16. Include diagram and details of proposed mimic bus.
17. Include schematic and wiring diagrams for power, signal, and control wiring.
18. Include report of emergency system(s) overcurrent devices selective coordination with all supply side overcurrent protective devices.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

D. Delegated Design Submittal:
   1. For arc-flash hazard study.
   2. For arc-flash labels.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.
B. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Routine maintenance requirements for switchboards and all installed components.
      b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
      c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.
1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
B. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency’s Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
C. Handle and prepare switchboards for installation according to NECA 400.

1.11 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
B. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

1.12 COORDINATION
A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.13 WARRANTY
A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 SWITCHBOARDS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.
B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
E. Comply with NEMA PB 2.
F. Comply with NFPA 70.
G. Comply with UL 891.
H. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Manually operated, and stationary mounted, Individual construction.
   3. Sections front and rear aligned.
I. Nominal System Voltage: 480Y/277 V.
J. Main-Bus Continuous: As shown on drawings.
K. Indoor Enclosures: Steel, NEMA 250, Type 1.
L. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

M. Barriers: Between adjacent switchboard sections.

N. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

O. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

P. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

Q. Arc Energy Reduction
   1. Provide for circuit breakers 1200A and larger with one of the following:
      a. An energy reducing maintenance bypass switch with visual status indicator. Switch, indicator, and associated circuitry and connections shall meet the requirements of NEC article 240.87.

R. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

S. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.

T. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
   1. Set back from front to clear circuit-breaker removal mechanism.
   2. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
   3. Bottom shall be insulating, fire-resistant material with separate holes for cable drops into switchboard.
   4. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

U. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
   3. Copper feeder circuit-breaker line connections.
   5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
   6. Disconnect Links:
      a. Isolate neutral bus from incoming neutral conductors.
      b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
   7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
V. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

W. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.2 SURGE PROTECTION DEVICES

A. SPD’s are not to be supplied as integral to switchboards. Refer to Section 264313 Surge Protection for Low-Voltage Electrical Power Circuits for requirements.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. In the emergency distribution system(s), provide devices to selectively coordinate with all supply side overcurrent protective devices.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and I^2t response.
   4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
   6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   8. MCCB Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
      c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
      d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
      f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
      g. Undervoltage Trip: Set to operate at 35 to 70 percent of rated voltage without intentional time delay.
      h. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
      i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
C. Insulated-Case Circuit Breaker (ICCB): 80 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
   1. Fixed circuit-breaker mounting.
   2. Two-step, stored-energy closing.
   3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time time adjustments.
      c. Ground-fault pickup level, time delay, and $I^2t$ response.
   4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
   5. Remote trip indication and control.
   6. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
   7. Control Voltage: 120-V ac.

2.4 INSTRUMENTATION
A. Instrument Transformers: NEMA EI 21.1, and the following:
   1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
   2. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
   3. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit breaker, ground-fault protection.
B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
      a. Phase Currents, Each Phase: Plus or minus 1 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      d. Megawatts: Plus or minus 2 percent.
      e. Megavars: Plus or minus 2 percent.
      f. Power Factor: Plus or minus 2 percent.
      g. Frequency: Plus or minus 0.5 percent.
      h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
      i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
      j. Contact devices to operate remote impulse-totalizing demand meter.
   2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
   3. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.
      a. Hardwired Points:
         1) Control: On-off operation, one for each relay.

2.5 CONTROL POWER
A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
B. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES
A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
B. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.
C. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548 “Seismic Controls for Electrical Systems” or manufacturer’s instructions.

2.7 IDENTIFICATION
A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.
   1. Nameplate: At least 0.032-inch- (0.813-mm-) thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.
B. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.
C. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.
D. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 EXECUTION
3.1 EXAMINATION
A. Receive, inspect, handle, and store switchboards according to NECA 400.
   1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer’s instructions.
   2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
   3. Protect from moisture, dust, dirt, and debris during storage and installation.
   4. Install temporary heating during storage per manufacturer's instructions.
B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install switchboards and accessories according to NECA 400.
B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 033000 “Cast-in-Place Concrete.”
1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches (50-mm) above concrete base after switchboard is anchored in place.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.

3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to switchboards.

6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Install spare-fuse cabinet.

H. Comply with NECA 1.

3.3 CONNECTIONS

A. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

B. Support and secure conductors within the switchboard according to NFPA 70.

C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections:

1. Acceptance Testing:
a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.

b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment per NFPA 70.


4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

5. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
   c. Instruments and Equipment: 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

B. Switchboard will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION
SECTION 262416
PANELBOARDS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.
   3. Load centers.
   4. Electronic-grade panelboards.

1.3 DEFINITIONS
A. ATS: Acceptance testing specification.
B. GFCI: Ground-fault circuit interrupter.
C. GFEP: Ground-fault equipment protection.
D. HID: High-intensity discharge.
E. MCCB: Molded-case circuit breaker.
F. SPD: Surge protective device.
G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of panelboard.
   1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
   2. Include dimensions and manufacturers’ technical data on features, performance, electrical characteristics, ratings, and finishes.
B. Shop Drawings: For each panelboard and related equipment.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers’ catalog sheets with complete technical data for each item being furnished.
   7. Include dimensioned plans, elevations, sections, and details.
   8. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
9. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
10. Detail bus configuration, current, and voltage ratings.
11. Short-circuit current rating of panelboards and overcurrent protective devices.
12. Include evidence of NRTL listing for series rating of installed devices.
13. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
14. Include wiring diagrams for power, signal, and control wiring.
15. Key interlock scheme drawing and sequence of operations.
16. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS
A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 “Operation and Maintenance Data,” include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Two spares for each type of panelboard cabinet lock.
   2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
   3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE
A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
B. Handle and prepare panelboards for installation according to NECA 407.

1.10 FIELD CONDITIONS
A. Environmental Limitations:
1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature:
      1) Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C) for interior mounted equipment.
      2) Not exceeding minus 22 deg F (minus 30 deg C) to plus 122 deg F (plus 50 deg C) for exterior mounted equipment.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet (2000 m).

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

1.11 WARRANTY
A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
   1. Panelboard Warranty Period: 24 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fail in materials or workmanship within specified warranty period.
   1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS
A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Flush- and surface-mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b. Outdoor Locations: NEMA 250, Type 3R.
      c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids:
   NEMA 250, Type 12.
   1) Mechanical rooms.
   2) Workshops
   3) Design Studios
   4) Space where extensive mechanical equipment, duct work, piping, etc. are located in close proximity.

2. Height: 84 inches (2.13 m) maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.

5. Finishes:
   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Back Boxes: Same finish as panels and trim.

F. Incoming Mains:
   1. Location: Convertible between top and bottom.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:
      a. Plating shall run entire length of bus.
      b. Bus shall be fully rated the entire length.
   2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   4. Isolated Ground Bus (where noted on drawings): Adequate for branch-circuit isolated ground conductors; insulated from box. Where isolated ground transformers or feeders shown with isolated ground conductors on the one-line diagram.
5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. Rated 200 percent of full load current for K-factor rated transformers, and any transformer shown on the riser diagrams or one-line diagrams with 200% rated feeders.
7. Split Bus: Vertical buses divided into individual vertical sections.

H. Conductor Connectors: Suitable for use with conductor material and sizes.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

I. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

J. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
   1. Percentage of Future Space Capacity: 20 percent.

K. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
   1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
   2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 POWER PANELBOARDS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: As indicated on drawings and schedules.


F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
C. Mains: As indicated on drawings and schedules.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.4 DISCONNECTING AND OVERTURE PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:
   a. Inverse time-current element for low-level overloads.
   b. Instantaneous magnetic trip element for short circuits.
   c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.


3. Electronic Trip Circuit Breakers:
   a. RMS sensing.
   b. Field-replaceable rating plug or electronic trip.
   c. Digital display of settings, trip targets, and indicated metering displays.
   d. Multi-button keypad to access programmable functions and monitored data.
   e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
   f. Integral test jack for connection to portable test set or laptop computer.
   g. Field-Adjustable Settings:
      1) Instantaneous trip.
      2) Long- and short-time pickup levels.
      3) Long and short time adjustments.
      4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).


9. MCCB Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Breaker handle indicates tripped status.
   c. UL listed for reverse connection without restrictive line or load ratings.
   d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
2.5 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.
   1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
   1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Handle Padlock Attachment: Handle attachment for 1, 2, or 3 pole breakers to lock breaker in ON or OFF position.
PART 3 EXECUTION

3.1 EXAMINATION
A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equip-
ment fits in allocated space in, and comply with, minimum required clearances specified in
NFPA 70.
B. Receive, inspect, handle, and store panelboards according to NECA 407.
C. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have
been subjected to water saturation.
D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances
and other conditions affecting performance of the Work.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INTEGRATED POWER AND CONTROL SOLUTIONS EQUIPMENT
A. As a voluntary alternate provide the panelboards, lighting controls, dry-type transformers, and other
electrical room components, as a factory assembled UL Listed unit. It is the contractor’s responsi-
bility to provide coordination drawings indicating code required working clearances are able to be
maintained as well as door swings and locations. This must be approved by the Owner and Archi-
tect.

3.3 INSTALLATION
A. Coordinate layout and installation of panelboards and components with other
construction that pen-
etrates walls or is supported by them, including electrical and other types of equipment, raceways,
piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain re-
quired workspace clearances and required clearances for equipment access doors and panels.
B. Comply with NECA 1.
C. Install panelboards and accessories according to NECA 407.
D. Equipment Mounting:
   1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for
      concrete base specified in Section 033000 "Cast-in-Place Concrete."
   2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and tempo-
rary blocking of moving parts from panelboards.
F. Mount top of trim at a maximum of 90 inches (2286 mm) above finished floor unless otherwise indi-
cated. Operating handle of top-most circuit breaker, in on position, shall not be higher than 79
   inches (2000 mm) above finished floor or grade.
G. Mount panelboard cabinet plumb and rigid without distortion of box.
H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
I. Mounting panelboards with space behind is recommended for damp, wet, or dirty locations. The
   steel slotted supports in the following paragraph provide an even mounting surface and the recom-
   mended space behind to prevent moisture or dirt collection.
J. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient
   steel slotted supports vertically.
K. Install overcurrent protective devices and controllers not already factory installed.
1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer’s written instructions.

L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

M. Install filler plates in unused spaces.

N. Stub four 1-inch (27-EMT) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-EMT) empty conduits below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

P. Mount spare fuse cabinet in accessible location.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

F. Label panelboards “LIFE SAFETY” PER NEC 110 AND 700 as applicable to the branch they serve.

3.5 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

C. Panelboards will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.7 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.8 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION
SECTION 262726
WIRING DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. GFCI receptacles.
   2. SPD receptacles.
   3. Twist-locking receptacles.
   4. Pendant cord-connector devices.
   5. Cord and plug sets.
   6. Toggle switches.
   7. Wall plates.
   8. Floor service outlets.

1.3 DEFINITIONS
A. Abbreviations of Manufacturers' Names:
   1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
B. BAS: Building automation system.
C. EMI: Electromagnetic interference.
D. GFCI: Ground-fault circuit interrupter.
E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
F. RFI: Radio-frequency interference.
G. SPD: Surge protective device.
H. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
6. Manufacturers' catalog sheets with complete technical data for each item being furnished.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Samples: One cut, stamped, or engraved plate for approval.

E. Provide separate submittal directly to the Architect for approval of color and finishes of devices and plates. This submittal shall include all samples. Any devices submittal will be reviewed for technical performance only. Color and finishes must be approved by the project Architect.

1.5 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.

PART 2 PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS
A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
   1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
   2. Devices shall comply with the requirements in this Section.

D. Devices for Owner-Furnished Equipment:
   1. Receptacles: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.

E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 MANUFACTURERS
A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Eaton. (Arrow Hart is acceptable only where noted.)
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
2.3 STRAIGHT-BLADE RECEPTACLES

A. Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton; 5361 (single), 5362 (duplex). (Arrow Hart AH5362)
      b. Hubbell; HBL5361 (single), HBL5352 (duplex).
      c. Leviton; 5361 (single), 5362 (duplex).
      d. Pass & Seymour; 5361 (single), 5362 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton; IG5362. (Arrow Hart IG5362)
      b. Hubbell; IG5362.
      c. Leviton; 5362IG.
      d. Pass & Seymour; IG5362.
   2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.4 GFCI RECEPTACLES

A. General Description:
   1. 2015 UL 943/CSA C22.2 No 144.1/ANCE NMX-J-250 Compliant.
   2. Self-testing, auto-monitoring with test-fail indication, with disconnection of power in case of test failure.
   3. Straight blade, feed-through type.
   4. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
   5. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Hubbell; GFRST20.
      c. Leviton; GFNT2.
      d. Pass & Seymour; 2097.

C. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton TRSGF20
      b. Hubbell; GFTRST20.
      c. Leviton GFTR2
      d. Pass & Seymour; 1597TR.

D. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
1. **Products:** Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Eaton; SGFH20.
   b. Hubbell; GFRST83.
   c. Leviton; N7899-HF.
   d. Pass & Seymour; 2095HG.

### 2.5 **PLUG-IN TYPE DEVICES**

A. Equivalent devices to those listed above (receptacles) and below (switches) from the following manufactures in the series listed may be used instead of traditional wired devices.

1. Eaton: ArrowLink Modular Wiring Devices.
3. Leviton: Lev-Lok Modular Wiring Devices
4. Pass & Seymour: PlugTail Modular Wiring Devices

B. **Description:**

1. Device shall be plug connected, with a pigtail connector. The pigtail shall be connected to the building wiring. Provision shall be made for the pigtail connector to keep out construction debris including drywall compound, paint, and dust.
2. Device shall comply with all standards for traditional wired device and be equivalent grade and function as traditional wired device it replaces.

### 2.6 **TWIST-LOCKING RECEPTACLES**

A. **Twist-Lock, Single Convenience Receptacles, 125 V, 20 A:** Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Eaton; CWL520R.
   b. Hubbell; HBL2310.
   c. Leviton; 2310.
   d. Pass & Seymour; L520-R.

B. **Twist-Lock, Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:** comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Eaton; IGL520R.
   b. Hubbell; IG2310.
   c. Leviton; 2310-IG.
   d. Pass & Seymour; IG4700.

2. **Description:**

   a. Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
   b. Grounding: Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

### 2.7 **PENDANT CORD-CONNECTOR DEVICES**

A. **Description:**

1. Matching, locking-type plug and receptacle body connector.
2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 CORD AND PLUG SETS
A. Description:
   1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

2.9 TOGGLE SWITCHES
A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
B. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Single Pole:
         1) Eaton; AH1221.
         2) Hubbell; HBL1221.
         3) Leviton; 1221-2.
         4) Pass & Seymour; CSB20AC1.
      b. Two Pole:
         1) Eaton; AH1222.
         2) Hubbell; HBL1222.
         3) Leviton; 1222-2.
         4) Pass & Seymour; CSB20AC2.
      c. Three Way:
         1) Eaton; AH1223.
         2) Hubbell; HBL1223.
         3) Leviton; 1223-2.
         4) Pass & Seymour; CSB20AC3.
      d. Four Way:
         1) Eaton; AH1224.
         2) Hubbell; HBL1224.
         3) Leviton; 1224-2.
         4) Pass & Seymour; CSB20AC4.
C. Pilot-Light Switches, 20 A:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eaton; AH1221PL for 120 and 277 V.
      b. Hubbell; HBL1201PL for 120 and 277 V.
      c. Leviton; 1221-LH1.
      d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
   2. Description: Single pole, with LED-lighted handle, illuminated when switch is off.
D. Key-Operated Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Eaton; AH1221L.
   b. Hubbell; HBL1221L.
   c. Leviton; 1221-2L.
   d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Hubbell; HBL1557.
   c. Leviton; 1257.
   d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Eaton; 1995L.
   b. Hubbell; HBL1557L.
   c. Leviton; 1257L.
   d. Pass & Seymour; 1251L.

### 2.10 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Refer to schedule on drawings.
3. Material for Unfinished Spaces: Refer to schedule on drawings.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

### 2.11 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

1. Refer to schedule on drawings for additional information regarding floor service devices.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, die-cast aluminum with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet:

1. Refer to schedule on drawings for additional information regarding floor service devices.
2.12 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Pass & Seymour/Legrand.
   3. Square D/Schneider Electric.
   4. Thomas & Betts Corporation.
   5. Wiremold/Legrand.

B. Description:
   1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
   2. Comply with UL 514 scrub water exclusion requirements.
   3. Service-Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks complying with requirements in Section 271500 “Communications Horizontal Cabling.”
   4. Size: Selected to fit nominal 3-inch (75-mm) cored holes in floor and matched to floor thickness.
   5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
   6. Closure Plug: Arranged to close unused 3-inch (75-mm) cored openings and reestablish fire rating of floor.
   7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two, four-pair cables that comply with requirements in Section 271500 “Communications Horizontal Cabling.”

2.13 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Wiremold/Legrand.

B. Description:
   1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
   2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Multioutlet Harness:
   1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
   2. Receptacle Spacing: 12 inches (300 mm).
   3. Wiring: No. 12 AWG solid, Type THHN copper, two circuit, connecting alternating receptacles.

2.14 FINISHES

A. Device Color:
   1. Wiring Devices Connected to Normal Power System: Refer to schedules on drawings for finishes and colors unless otherwise indicated or required by NFPA 70 or device listing.
   3. SPD Devices: Blue.
   4. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

B. Wall Plate Color: For plastic covers, match device color.
PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
   1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtail existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
   1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
   5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
   6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
   7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
   8. Tighten unused terminal screws on the device.
   9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
G. **Arrangement of Devices:** Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. **Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.**

I. **Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for rough-in of conduit and equipment, the contractor shall check with other contractors concerned, to determine exact field location of the above items. In addition, he shall check for exact direction of door swings so that local switches are properly located on the strike side.**

J. **Where more than one wiring device occurs in any one location, arrange devices in gangs with common cover plate, excluding wall box dimmers. Where ganged switches serving 277V lighting are served by different circuits, so as to result in the voltage between switches exceeding 300V, provide barriers in box per NEC Section 404-8(b).**

K. **In locations where several pieces of wall-mounted equipment such as wall switches and thermostats are in the same general area, all shall be installed and grouped in a neat, orderly fashion, all of the same horizontal or vertical center line, whichever the case may be. Variation from this direction shall be approved by the owner or the owner’s representative. All receptacles and switches shall be mounted at a height as directed in drawings.**

L. **Install devices, accessories, and assemblies level, plumb, square with building lines, and secure.**

M. **Install GFCI type receptacles where located in bathrooms, kitchens, garages, outdoors, or within six feet of a water source.**

N. **Install GFCI type receptacles at all locations indicated as EWC (electric water cooler).**

O. **Install GFCI type receptacles at all locations for vending machines.**

P. **Install GFCI type receptacle with an in-use weatherproof cover for all receptacles indicated as weatherproof.**

Q. **Devices mounted in boxes which are not flush with the surface of the wall shall be installed so that the mounting yoke or strap of the device is held rigidly at the surface of the wall, but not supported by the wall. Provide washers or spacers to fill in the area between the box and the finished wall line.**

R. **Receptacles shall be installed so that the removal of the receptacle does not interrupt the continuity of the circuit.**

S. **Receptacles and switches shall have their device screws covered by two wraps of PVC electrical tape. Receptacles with integral hinged plastic covers meet this requirement.**

T. **For installations of multioutlet assemblies or service poles using multiple circuits, provide a multi-pole circuit breaker in panelboard for branch circuits.**

### 3.2 **GFCI RECEPTACLES**

A. **Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.**

### 3.3 **IDENTIFICATION**

A. **Comply with Section 260553 "Identification for Electrical Systems."**

B. **Switches:** Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.
C. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes. Characters to be 3/16” minimum height.

3.4 FIELD QUALITY CONTROL

A. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Perform the following tests and inspections:
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION
SECTION 262816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Fusible switches.
      2. Nonfusible switches.
      3. Receptacle switches.
      4. Shunt trip switches.
      5. Molded-case circuit breakers (MCCBs).
      7. Enclosures.

1.3 DEFINITIONS
   A. NC: Normally closed.
   B. NO: Normally open.
   C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
      1. Enclosure types and details for types other than NEMA 250, Type 1.
      2. Current and voltage ratings.
      3. Short-circuit current ratings (interrupting and withstand, as appropriate).
      4. Include evidence of NRTL listing for series rating of installed devices.
      5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
         a. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.
   B. Shop Drawings: For enclosed switches and circuit breakers.
      1. Include plans, elevations, sections, details, and attachments to other work.
      2. Include wiring diagrams for power, signal, and control wiring.
      3. Provide coversheet indicating project title, project location, and vendor contact information.
      4. Organize submittal into logical sections and provide table of contents.
      5. Provide itemized bill of materials indicating model number and quantity for each product.
      6. On datasheets with multiple products, indicate which product is provided under this project.
7. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.

8. Manufacturers' catalog sheets with complete technical data for each item being furnished.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Fuse Pullers: Two for each size and type.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).


1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: two years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. ABB Inc.
   2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   5. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty:
   1. Single throw.
   2. Three pole.
   3. 600-V ac.
   4. 200 A and smaller.
   5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
   6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
   6. Hookstick Handle: Allows use of a hookstick to operate the handle.
   7. Lugs: Mechanical type, suitable for number, size, and conductor material.
   8. Service-Rated Switches: Labeled for use as service equipment.

2.3 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
   5. Hookstick Handle: Allows use of a hookstick to operate the handle.
   6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 RECEPTACLE SWITCHES

A. In the emergency distribution system(s), provide devices to selectively coordinate with all supply side overcurrent protective devices.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

C. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 600-V ac, 60 A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: 600-V ac, 60 A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

E. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

F. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

G. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
   4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.5 SHUNT TRIP SWITCHES

A. In the emergency distribution system(s), provide devices to selectively coordinate with all supply side overcurrent protective devices.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bussmann, an Eaton business
   2. Littelfuse, Inc.
   3. Mersen USA

C. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-current current rating when fitted with Class J fuses.

D. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 600-V ac, 60 A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

E. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: 600-V ac, 60 A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

F. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power source of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

G. Accessories:
   1. Oiltight key switch for key-to-test function.
   2. Oiltight red ON pilot light.
   3. Isolated neutral lug; 200 percent rating.
   4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
   5. Form C alarm contacts that change state when switch is tripped.
   6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac coil voltage.
   7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
   8. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   9. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
  10. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  11. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
  12. Hookstick Handle: Allows use of a hookstick to operate the handle.
  13. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.6 MOLDED-CASE CIRCUIT BREAKERS

A. In the emergency distribution system(s), provide devices to selectively coordinate with all supply side overcurrent protective devices.
B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.

C. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

D. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

E. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated. Circuit breaker/circuit breaker combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations.

F. MCCBs shall be equipped with a device for locking in the isolated position.

G. Lugs shall be suitable for 140 deg F (60 deg C) rated wire on 125-A circuit breakers and below.

H. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.


K. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

L. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

M. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

N. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

O. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

P. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring and Control."
6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
8. Auxiliary Contacts: One SPDT switch with “a” and “b” contacts; “a” contacts mimic circuit-breaker contacts, “b” contacts operate in reverse of circuit-breaker contacts.
9. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
11. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
12. Electrical Operator: Provide remote control for on, off, and reset operations.
13. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.7 ENCLOSURES
A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).
C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
D. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the front cover of the enclosure (NEMA 250 Type 1). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

PART 3 EXECUTION
3.1 EXAMINATION
A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Commencement of work shall indicate Installer’s acceptance of the areas and conditions as satisfactory.
3.2 PREPARATION
A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Owner's written permission.
   4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS
A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
   4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.4 INSTALLATION
A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
D. Install fuses in fusible devices.
E. Comply with NECA 1.

3.5 IDENTIFICATION
A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL
A. Perform tests and inspections with the assistance of a factory-authorized service representative.
B. Tests and Inspections for Switches:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, grounding, and clearances.
      c. Verify that the unit is clean.
      d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
      e. Verify that fuse sizes and types match the Specifications and Drawings.
      f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the two following methods:
   1) Use a low-resistance ohmmeter.
      (a) Compare bolted connection resistance values to values of similar connections. Inve-
          stigate values that deviate from those of similar bolted connections by more than
          50 percent of the lowest value.
   2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench
      method in accordance with manufacturer's published data or NETA ATS Table 100.12.
      (a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the
          absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifi-
   cations and shown on the Drawings.

i. Verify correct phase barrier installation.

j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:
   a. Perform resistance measurements through bolted connections with a low-resistance ohm-
      meter. Compare bolted connection resistance values to values of similar connections. Inve-
      stigate values that deviate from adjacent poles or similar switches by more than 50 per-
      cent of the lowest value.
   b. Measure contact resistance across each switchblade fuseholder. Drop values shall not ex-
      ceed the high level of the manufacturer's published data. If manufacturer's published data
      are not available, investigate values that deviate from adjacent poles or similar switches by
      more than 50 percent of the lowest value.
   c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and
      phase-to-ground with switch closed, and across each open pole. Apply voltage in accord-
      ance with manufacturer's published data. In the absence of manufacturer's published data,
      use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than
      those published in Table 100.1 or as recommended in manufacturer's published data.
   d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other
      by more than 15 percent.
   e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems,
      Low-Voltage."

C. Tests and Inspections for Molded Case Circuit Breakers:
   1. Visual and Mechanical Inspection:
      a. Verify that equipment nameplate data are as described in the Specifications and shown on
         the Drawings.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, grounding, and clearances.
      d. Verify that the unit is clean.
      e. Operate the circuit breaker to ensure smooth operation.
      f. Inspect bolted electrical connections for high resistance using one of the two following
         methods:
         1) Use a low-resistance ohmmeter.
            (a) Compare bolted connection resistance values to values of similar connections. Inve-
                stigate values that deviate from those of similar bolted connections by more than
                50 percent of the lowest value.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench
            method in accordance with manufacturer's published data or NETA ATS Table 100.12.
            (a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the
                absence of manufacturer's published data, use NETA ATS Table 100.12.
      g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
   c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
   e. Determine the following by primary current injection:
      1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
      2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
      3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
      4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
   f. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
   g. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
   h. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
   c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.
   1. Test procedures used.
   2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
   3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

END OF SECTION
SECTION 263213.16
GASEOUS EMERGENCY ENGINE GENERATORS

PART 1 GENERAL

1.1 SUMMARY
A. Section includes packaged engine generators for emergency use with the following features:
   1. Natural gas engine.
   2. Gaseous fuel system.
   3. Control and monitoring.
   4. Generator overcurrent and fault protection.
   5. Generator, exciter, and voltage regulator.
   6. Outdoor engine generator enclosure.
   8. Finishes.

B. Related Requirements:
   1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.2 DEFINITIONS
A. EPS: Emergency power supply.
B. EPSS: Emergency power supply system.
C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   2. Include thermal damage curve for generator.
   3. Include time-current characteristic curves for generator protective device.
   4. Include fuel consumption in cubic feet per hour (cubic meters per hour) at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
   5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
   6. Include airflow requirements for cooling and combustion air in cubic feet per minute (cubic meters per minute) at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F (35, 27, 21, and 10 deg C). Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
   7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.

6. Manufacturers' catalog sheets with complete technical data for each item being furnished.

7. Include plans and elevations for engine generator and other components specified.

8. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

9. Identify fluid drain ports and clearance requirements for proper fluid drain.

10. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

11. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and supported equipment. Include base weights.

12. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

13. Include report of emergency system(s) overcurrent devices selective coordination with all supply side overcurrent protective devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Source Quality-Control Reports: Including, but not limited to, the following:
   1. Certified summary of prototype-unit test report.
   2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
   4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
   6. Report of exhaust emissions showing compliance with applicable regulations.

C. Field quality-control reports.

D. Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
      b. Operating instructions laminated and mounted adjacent to generator location.
      c. Training plan.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.7 QUALITY ASSURANCE
A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
B. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
C. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles (321 km) of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

1.8 COORDINATION
A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.9 WARRANTY
A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 PRODUCTS
2.1 MANUFACTURERS
A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Caterpillar; Engine Div.
   2. Generac Power Systems, Inc.
   3. Kohler Co.; Generator Division.
   4. Magnetek, Inc.
B. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS
A. B11 Compliance: Comply with B11.19.
B. NFPA Compliance:
   2. Comply with NFPA 70.
   3. Comply with NFPA 110 requirements for Level 1 EPSS.
C. UL Compliance: Comply with UL 2200.
D. Engine Exhaust Emissions: Comply with EPA Tier 3 requirements and applicable state and local government requirements.
E. Noise Emission: Comply with applicable state and local government requirement criteria for maximum noise level at adjacent property boundaries due to sound emitted by engine generator, including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

F. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: 5 to 104 deg F (Minus 15 to plus 40 deg C).
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to 750 feet (300 m).

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. EPSS Class: Engine generator shall be classified as Class 6 according to NFPA 110.

D. Service Load: 350 kVA.

E. Power Factor: 0.8, lagging.

F. Frequency: 60 Hz.

G. Voltage: 480-V ac.

H. Phase: Three-phase, four-wire wye.

I. Induction Method: Turbocharged.

J. Governor: Adjustable isochronous, with speed sensing.

K. Mounting Frame: Structural-steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

L. Capacities and Characteristics:
1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries, with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Nameplates: For each major system component to identify manufacturer’s name and address, and model and serial number of component.

M. Engine Generator Performance:
1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage, from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency, from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.4 ENGINE

A. Fuel: Natural gas.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid mounted.
   1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
   2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
   3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and with UL 499.

E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.
   1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   2. Size of Radiator: Adequate to contain expansion of total system coolant, from cold start to 110 percent load condition.
   3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant-system pressure for engine used. Equip with gage glass and petcock.
   4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
      a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
      b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Muffler/Silencer: Semicritical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 18 dB at 500 Hz.
   2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 85 dBA or less.

G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
H. Starting System: 24-V electric, with negative ground.
   1. Components: Sized so they are not damaged during a full engine-cranking cycle, with ambient temperature at maximum specified in "Performance Requirements" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: As required by NFPA 110 for system level specified.
   4. Battery: Nickel cadmium, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories. Provide disconnect switch with lockout/tagout capability for local disconnection of generator.
   6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F (10 deg C) regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
   7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
   9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for nickel-cadmium batteries. Unit shall comply with UL 1236 and include the following features:
      a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
      b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 to 140 deg F (minus 40 to plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.
      c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
      e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
      f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 GASEOUS FUEL SYSTEM
A. Natural Gas Piping: Comply with requirements in Section 231123 "Facility Natural Gas Piping."
B. Gas Train: Comply with NFPA 37.
C. Engine Fuel System:
   1. Natural Gas, Vapor-Withdrawal System:
      a. Carburetor.
      b. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
   2. Fuel Filters: One for each fuel type.
   4. Flexible Fuel Connectors: Minimum one for each fuel connection.
5. Fuel change gas pressure switch.

2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Provide minimum run-time control set for 30 minutes, with override only by operation of a remote emergency-stop switch.

C. Comply with UL 508A.

D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.

E. Control and Monitoring Panel:
   1. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
   2. Instruments: Located on the control and monitoring panel and viewable during operation.
      a. Engine lubricating-oil pressure gage.
      b. Engine-coolant temperature gage.
      c. DC voltmeter (alternator battery charging).
      d. Running-time meter.
      e. AC voltmeter, for each phase connected to a phase selector switch.
      f. AC ammeter, connected to a phase selector switch.
      g. AC frequency meter.
      h. Generator-voltage adjusting rheostat.
   3. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication as required by NFPA 110 for Level 1 system, including the following:
      a. Cranking control equipment.
      c. Control switch not in automatic position alarm.
      d. Overcrank alarm.
      e. Overcrank shutdown device.
      f. Low water temperature alarm.
      g. High engine temperature pre-alarm.
      h. High engine temperature.
      i. High engine temperature shutdown device.
      j. Overspeed alarm.
      k. Overspeed shutdown device.
      l. Coolant low-level alarm.
      m. Coolant low-level shutdown device.
      n. Coolant high-temperature prealarm.
      o. Coolant high-temperature alarm.
      q. Coolant high-temperature shutdown device.
      r. EPS load indicator.
      s. Battery high-voltage alarm.
      t. Low-cranking voltage alarm.
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u. Battery-charger malfunction alarm.
v. Battery low-voltage alarm.
w. Lamp test.
x. Contacts for local and remote common alarm.
y. Low-starting air pressure alarm.
z. Low-starting hydraulic pressure alarm.

bb. Air shutdown damper alarm when used.
cc. Air shutdown damper shutdown device when used.
dd. Generator overcurrent-protective-device not-closed alarm.

e. Generator motor stability

F. Connection to Datalink:
1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
2. Provide connections for datalink transmission of indications to remote data terminals via Ethernet. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."
3. Provide connection for datalink transmission of indicated signals to Division 23 Controls contractor. Refer to specification 230993 for emergency generator interface requirements. Division 26 responsible for all required generator components and protocols required.

G. Common Remote Panel with Common Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

H. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Coolant low-temperature alarm.
3. High engine temperature pre-alarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low-fuel main tank alarm.
8. Low coolant level alarm.
9. Low-cranking voltage alarm.
10. Contacts for local and remote common alarm.
12. Air shutdown damper when used.
14. Control switch not in automatic position alarm.
15. Lamp test.
16. Low-cranking voltage alarm.
17. Generator overcurrent-protective-device not-closed alarm.

I. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

J. Remote Emergency-Stop Switch: Flush; wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
   1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. In the emergency distribution system(s), provide devices to selectively coordinate with all supply side overcurrent protective devices.

C. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
   2. Trip Settings: Selected to coordinate with generator thermal damage curve.
   3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
   4. Mounting: Adjacent to or integrated with control and monitoring panel.

D. Ground-Fault Indication: Comply with NFPA 70 Article 700, "Emergency System" signals for ground fault.
   1. Indicate ground fault with other engine generator alarm indications.
   2. Trip generator protective device on ground fault.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide six-lead alternator.

E. Range: Provide limited range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.
   1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
   2. Maintain voltage within 20 percent on one step, full load.
   3. Provide anti-hunt provision to stabilize voltage.
   4. Maintain frequency within 15 percent and stabilize at rated frequency within five seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 13 percent, maximum.
2.9 **OUTDOOR ENGINE GENERATOR ENCLOSURE**

A. Description: Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph (160 km/h).

C. Hinged Doors: With padlocking provisions.

D. Space Heater: Thermostatically controlled and sized to prevent condensation.

E. Lighting: Provide weather-resistant LED lighting with 30 fc (330 lx) average maintained.

F. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

G. Muffler Location: Within enclosure.

H. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.
   2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
   3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

I. Interior Lights with Switch: Factory-wired, vaporproof luminaires within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
   1. DC lighting system for operation when remote source and generator are both unavailable.

J. Sound Attenuation: Provide sound attenuation to reduce total sound output of generator set while operating at rated output to 75 dB at 25 ft.

2.10 **VIBRATION ISOLATION DEVICES**

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
   3. Number of Layers: Two.
   4. Minimum Deflection: 1 inch (25 mm).

B. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.

C. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.

D. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.
2.11 **FINISHES**

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 **SOURCE QUALITY CONTROL**

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
   2. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
   3. Test generator, exciter, and voltage regulator as a unit.
   4. Full-load run.
   5. Maximum power.
   7. Transient and steady-state governing.
   10. Report factory test results within 10 days of completion of test.

**PART 3 EXECUTION**

3.1 **EXAMINATION**

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections to verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 **INSTALLATION**

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers’ written installation and alignment instructions and with NFPA 110.

C. Equipment Mounting:
   1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
   3. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch (25 mm) on 12-inch- (100-mm-) high concrete base. Secure enclosure to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548 "Seismic Controls for Electrical Systems." Division 3 ERP#3 specifications and detailed within Division #3 drawings.20

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Gaseous Fuel Piping:
1. Natural gas piping, valves, and specialties for gas distribution are specified in Section 23123 "Facility Natural Gas Piping."

F. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine generator and heat exchanger with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Gaseous Fuel Connections:
   1. Connect fuel piping to engines with a gate valve and union and flexible connector.
   2. Install manual shutoff valve in a remote location to isolate gaseous fuel supply to the generator.
   3. Vent gas pressure regulators outside building a minimum of 60 inches (1500 mm) from building openings.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

I. Connect transfer switches to generator.

J. Connect all heaters, and accessories to emergency power.

3.4 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:
   1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.
      a. Visual and Mechanical Inspection:
         1) Compare equipment nameplate data with Drawings and the Specifications.
         2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, and grounding.
4) Verify that the unit is clean.

b. Electrical and Mechanical Tests:
   1) Perform insulation-resistance tests according to IEEE 43.
      (a) Machines Larger Than 200 hp (150 kW): Test duration shall be 10 minutes. Calculate polarization index.
      (b) Machines 200 hp (150 kW) or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.
   2) Test protective relay devices.
   3) Verify phase rotation, phasing, and synchronized operation as required by the application.
   4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
   5) Perform vibration test for each main bearing cap.
   6) Conduct performance test according to NFPA 110.
   7) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.

3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.

7. Exhaust Emissions Test: Comply with applicable government test criteria.

8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.

10. Noise Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet (8 m) from edge of the generator enclosure, and compare measured levels with required values.

D. Coordinate tests with tests for transfer switches and run them concurrently.

E. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

F. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Remove and replace malfunctioning units and retest as specified above.

J. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

L. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels, so terminations and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

M. Submit report to show emergency system(s) overcurrent devices selective coordination with all supply side overcurrent protective devices.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months’ full maintenance by skilled employees of manufacturer’s authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer’s authorized replacement parts and supplies.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION
SECTION 263214
GENERATOR CONNECTION CABINET

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Generator Connection Cabinet (also referred to as Tap Box and Docking Station)
   2. Accessory components and features.
   3. Identification.

1.3 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Generator Connection Cabinets shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of connection cabinet. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
B. Shop Drawings: For each connection cabinet and related equipment.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment.
   8. Detail enclosure type.
   9. Detail bus configuration, current, and voltage ratings.
   11. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
   12. Include diagram and details of proposed mimic bus.
   13. Include schematic and wiring diagrams for power, signal, and control wiring.
   14. Include report of emergency system(s) overcurrent devices selective coordination with all supply side overcurrent protective devices.
C. Refer to Section 018113 “Sustainable Design Requirements” for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified Installer.
B. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For generator connection cabinets and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017800 "Closeout Submittals," include the following:
   1. Routine maintenance requirements for generator connection cabinets and all installed components.

1.7 QUALITY ASSURANCE
A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
B. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
C. Source Limitations: Obtain generator connection cabinets, components, and accessories from single source from single manufacturer.
D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for generator connection cabinets including clearances between generator connection cabinets and adjacent surfaces and other items. Comply with indicated maximum dimensions.
E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
F. Comply with NFPA 70.
G. Comply with UL.

1.8 PROJECT CONDITIONS
A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving generator connection cabinets into place.
B. Environmental Limitations:
   1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet (2000 m).
1.9 COORDINATION

A. Coordinate layout and installation of generator connection cabinets and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. American Midwest Power (AMP)
   2. APT
   3. ASCO
   4. ESL Power Systems
   5. HIPOWER
   6. LEX Products
   7. Power Products Inc.
   8. Powertron
   9. Trystar

B. All equipment shall be new.

C. Generator tap box manufacturer must have produced and sold generator tap boxes as a standard product for a minimum of (2) years.

D. Contractor shall be responsible for the equipment until it has been installed and is finally inspected, tested and accepted in accordance with the requirements of this Specification.

E. Nominal System Voltage: 480Y/277 V.

F. Bus Continuous: As shown on drawings.

G. Generator tap box shall consist of cam-style male connectors and grounding terminals, all housed within a padlockable enclosure.

H. Generator tap box enclosure shall be Type 3R, constructed of continuous seam-welded, powder coated steel. The main access shall be through a hinged door that extends the full height of the enclosure. Access for portable generator cables with female cam-style plugs shall be via cable entry openings in the bottom of the enclosure. A hinged flap door shall be provided to cover the cable openings when cables are not connected; the hinged flap door shall allow cable entry only after the main access door has been opened. Enclosure shall be powder coated after fabrication; color shall be light gray RAL 7038.
I. Cam-style male connectors (inlets) shall be UL Listed single-pole separable type and rated 400 amps at 600VAC. Cam-style male connectors shall be color coded. Cam-style male connectors shall be provided for each phase and for ground, and shall also be provided for neutral if required. The ground cam-style male connectors shall be bonded to the enclosure, and a ground lug shall be provided for connection of the facility ground conductor. None of the cam-style male connectors shall be accessible unless the main access door is open.

J. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with tin-plated aluminum or copper feeder circuit-breaker line connections.

2.2 IDENTIFICATION
   A. Provide label of generator connection cabinet and instruction sign for operation of disconnect/over-current device in emergency distribution switchgear.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Examine generator connection cabinet before installation. Reject generator connection cabinets that are moisture damaged or physically damaged.
   B. Examine elements and surfaces to receive generator connection cabinets for compliance with installation tolerances and other conditions affecting performance of the Work.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Generator connection cabinet shall be installed as shown on the drawings and per the manufacturer’s written instructions. In addition, the installation shall meet the requirements of local codes, the National Electrical Code and National Electrical Contractors Association’s “Standard of Installation”.
   B. Equipment Mounting: Install generator connection cabinet on concrete base, 6-inch (100-mm) nominal thickness, reinforced. Comply with requirements for concrete base specified in Section 033000 “Cast-in-Place Concrete.”
      1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
      2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
      3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      4. Install anchor bolts to elevations required for proper attachment to generator connection cabinet.
   C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from generator connection cabinet and components.
   D. Comply with mounting and anchoring requirements specified in Section 260548 “Seismic Controls for Electrical Systems.”
   E. Operating Instructions: Frame and mount the printed basic operating instructions for generator connection cabinet. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on inside of front door of generator connection cabinet.
3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Generator Connection Cabinet Nameplates: Label each generator connection cabinet with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Generator connection cabinet will be considered defective if it does not pass tests and inspections.

END OF SECTION
SECTION 263600
TRANSFER SWITCHES

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes automatic transfer switches rated 600 V and less, including the following:
   1. Bypass/isolation switches.
B. Related Requirements:
   1. Section 213113 "Electric-Drive, Centrifugal Fire Pumps" for automatic transfer switches for fire pumps.
   2. Section 263213 “Engine Generators” for generator interface.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
   2. Include rated capacities, weights, operating characteristics, and accessories.
B. Shop Drawings:
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers’ catalog sheets with complete technical data for each item being furnished.
   7. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
   8. Include material lists for each switch specified.
   9. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
   10. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.
C. Refer to Section 018113 “Sustainable Design Requirements” for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For manufacturer-authorized service representative.
B. Field quality-control reports.
1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017800 “Closeout Submittals,” include the following:
      a. Features and operating sequences, both automatic and manual.
      b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE
A. Testing Agency Qualifications:
   1. Member company of NETA.
      a. Testing Agency’s Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 FIELD CONDITIONS
A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Owner’s written permission.

1.8 WARRANTY
A. Manufacturer’s Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 24 months from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NEMA ICS 1.
C. Comply with NFPA 99.
D. Comply with NFPA 110.
E. Comply with UL 1008 unless requirements of these Specifications are stricter.
F. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
G. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
   1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
   2. Short-time withstand capability for three cycles.
H. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

I. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

K. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.


M. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
   1. Provide pre-transfer contacts for each elevator controller.

N. Signal-After-Transfer Contacts or Switch Position Contacts: A set of normally open/normally closed dry contacts operates after a transfer to an emergency source. These contacts shall allow only one elevator to operate at time while on generator power.
   1. Provide post transfer contacts for each elevator controller.

O. Generator Start Circuit: The integrity of the generator control wiring shall be continuously monitored. Loss of integrity of the remote start circuit(s) shall initiate visual and audible annunciation of generator malfunction at the generator local and remote annunciator(s) and start the generator(s).

P. Service-Rated Transfer Switch:
   1. Comply with UL 869A and UL 489.
   2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
   3. In systems with a neutral, the bonding connection shall be on the neutral bus.
   4. Provide removable link for temporary separation of the service and load grounded conductors.
   5. Surge Protective Device: Service rated.

Q. Neutral Switching: Where four-pole switches are indicated, provide overlapping neutral contacts.

R. Neutral Terminal: Solid and fully rated unless otherwise indicated.

S. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

T. Battery Charger: For generator starting batteries.
   1. Float type, rated 2A.
   2. Ammeter to display charging current.
   3. Fused ac inputs and dc outputs.

U. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
V. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed tape markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."
   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
   4. Accessible via front access.

W. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ASCO (Schneider Electric)
      b. Cummins Power Generation
      c. Caterpillar; Engine Div.
      d. Eaton
      e. GE Zenith Controls.
      f. General Electric Company
      g. Hubbell Power Systems, Inc.
      h. Kohler Power Systems; Generator Division.
      i. MTU On Site Energy.

   B. Comply with Level 1 equipment according to NFPA 110.

   C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
      1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
      2. Switch Action: Double throw; mechanically held in both directions.
      3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
      4. Conductor Connectors: Suitable for use with conductor material and sizes.
      6. Main and Neutral Lugs: Mechanical type.
      7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
      8. Ground bar.
      9. Connectors shall be marked for conductor size and type according to UL 1008.

   D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
      1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

   E. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.
      1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
3. Fully automatic break-before-make operation with center off position.
4. Fully automatic break-before-make operation with transfer when two sources have near zero phase difference.

F. Automatic Closed-Transition Transfer Switches: Connect both sources to load momentarily. Transition is controlled by programming in the automatic transfer-switch controller.
   1. Fully automatic make-before-break operation when transferring between two available power sources.
   2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
   3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
      a. Initiation occurs without active control of generator.
      b. Automatic transfer-switch controller takes active control of generator to match frequency, phase angle, and voltage.
      c. Controls ensure that closed-transition load transfer closure occurs only when the two sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
   4. Failure of power source serving load initiates automatic break-before-make transfer.
   5. Provide connection to shunt-trip breaker to open with “failure to sync” signal to normal source feeder breaker.

G. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.


I. Electric Nonautomatic Switch Operation: Electrically actuated by push buttons designated “Normal Source” and “Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

J. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

K. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

L. Automatic Transfer-Switch Controller Features:
   1. Controller operates through a period of loss of control power.
   2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
   3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
   4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
   5. Test Switch: Simulate normal-source failure.
   6. Switch-Position Pilot Lights: Indicate source to which load is connected.
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
   a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
   b. Push-button programming control with digital display of settings.
   c. Integral battery operation of time switch when normal control power is unavailable.

M. Large-Motor-Load Power Transfer:
1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 TRANSFER SWITCH ACCESSORIES
A. Bypass/Isolation Switches:
1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
   a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.
   b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
   c. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations. Transfer switch and bypass/isolation switch shall be in isolated compartments.
   d. Transition: Provide closed-transition operation when transferring from main transfer switch to bypass/isolation switch on the same power source.
   e. Transition: Provide closed-transition operation when transferring between power sources.
   f. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
   g. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
   h. Manual Control: Constructed so load bypass and transfer-switch isolation can be performed by one person in no more than two operations in 15 seconds or less. Operating handles shall be externally operated.
   i. Automatic and Nonautomatic Control: Automatic transfer-switch controller shall also control the bypass/isolation switch.
   j. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
   k. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for legally required systems. Include results of test for the following conditions:
   a. Overvoltage.
   b. Undervoltage.
   c. Loss of supply voltage.
   d. Reduction of supply voltage.
   e. Alternative supply voltage or frequency is at minimum acceptable values.
   f. Temperature rise.
   g. Dielectric voltage-withstand; before and after short-circuit test.
   h. Overload.
   i. Contact opening.
   j. Endurance.
   k. Short circuit.
I. Short-time current capability.
   m. Receptacle withstand capability.
   n. Insulating base and supports damage.

PART 3 EXECUTION

3.1 INSTALLATION
   A. Floor-Mounting Switch: Anchor to floor by bolting.
      1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with require-
         ments for equipment bases and foundations specified in Section 033000 "Cast-in-Place Con-
         crete."
      2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
      3. Provide workspace and clearances required by NFPA 70.
   B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.
   C. Identify components according to Section 260553 "Identification for Electrical Systems."
   D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
   E. Comply with NECA 1.

3.2 IDENTIFICATION
   A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs
      as specified in Section 260553 "Identification for Electrical Systems."
   B. Transfer Switch Nameplates: Label each transfer switch with engraved metal or laminated-plastic
      nameplate mounted with corrosion-resistant screws.
   C. Label transfer switches “LIFE SAFETY” or “EQUIPMENT” per NEC 110 and 700 as applicable to
      the branch they serve.

3.3 CONNECTIONS
   A. Wiring to Remote Components: Match type and number of cables and conductors to generator
      sets, motor controls, control, and communication requirements of transfer switches as recom-
      mended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to
      accommodate required wiring.
   B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Con-
      ceal raceway and cables except in unfinished spaces.
      1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and
         Boxes for Electrical Systems."
   C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and
      without exceeding manufacturer's limitations on bending radii.
   D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
   E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Ca-
      bles."
   F. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."
   G. Connect twisted pair cable according to Section 271513 "Communications Copper Horizontal Ca-
      bling."
H. Route and brace conductors according to manufacturer's written instruction, and Section 260529
"Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and la-
bels.

I. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than
18 inches (457 mm) in length.

J. Provide all necessary connections between automatic transfer switches.

K. Provide all necessary connections between automatic transfer switches and generator(s).

L. Provide all necessary connections between automatic transfer switches and normal source feeder
breakers.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service rep-
resentative:

1. After installing equipment test for compliance with requirements according to NETA ATS.

2. Visual and Mechanical Inspection:
   a. Compare equipment nameplate data with Drawings and Specifications.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage, alignment, grounding, and required clearances.
   d. Verify that the unit is clean.
   e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding
      surfaces.
   f. Verify that manual transfer warnings are attached and visible.
   g. Verify tightness of all control connections.
   h. Inspect bolted electrical connections for high resistance using one of the following meth-
      ods, or both:
      1) Use of low-resistance ohmmeter.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench
         method according to manufacturer's published data.
   i. Perform manual transfer operation.
   j. Verify positive mechanical interlocking between normal and alternate sources.
   k. Perform visual and mechanical inspection of surge arresters.
   l. Inspect control power transformers.
      1) Inspect for physical damage, cracked insulation, broken leads, tightness of connec-
         tions, defective wiring, and overall general condition.
      2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
      3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and
         interlocks.

3. Electrical Tests:
   a. Perform insulation-resistance tests on all control wiring with respect to ground.
   b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's ac-
      ceptable values.
   c. Verify settings and operation of control devices.
   d. Calibrate and set all relays and timers.
   e. Verify phase rotation, phasing, and synchronized operation.
   f. Perform automatic transfer tests.
   g. Verify correct operation and timing of the following functions:
      1) Normal source voltage-sensing and frequency-sensing relays.
      2) Engine start sequence.
      3) Time delay on transfer.
      4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.

   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
   a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
   f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
   g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

   a. Verify grounding connections and locations and ratings of sensors.

B. Coordinate tests with tests of generator and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Transfer switches will be considered defective if they do not pass tests and inspections.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
   1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
   3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
3.5 STARTUP SERVICE
A. Engage a factory-authorized service representative to perform startup service.
B. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
C. Complete installation and startup checks according to manufacturer’s written instructions.
D. Coordinate this startup with that for generator equipment.

3.6 CLEANING
A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
B. Clean equipment internally, on completion of installation, according to manufacturer’s written instructions. Vacuum only; do not use compressed air for cleaning.

3.7 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.
C. Coordinate this training with that for generator equipment.

END OF SECTION
SECTION 265119
LED INTERIOR LIGHTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Interior solid-state luminaires that use LED technology.
   2. Lighting fixture supports.
B. Related Requirements:
   1. Section 260923 “Lighting Control Devices” for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Section 260936 “Modular Dimming Controls” for architectural dimming systems.
   3. Section 260943.03 “Distributed Digital Lighting Controls” for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.3 DEFINITIONS
A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Fixture: See “Luminaire.”
D. IP: International Protection or Ingress Protection Rating.
E. LED: Light-emitting diode.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers’ catalog sheets with complete technical data for each item being furnished.
   7. Arrange in order of luminaire designation.
   8. Include data on features, accessories, and finishes.
   9. Include physical description and dimensions of luminaires.
   10. Include emergency lighting units, including batteries and chargers.
   11. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
12. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in IES LM-79 and IES LM-80.
   a. Manufacturers’ Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   b. Provide certification of one of the following:
      1) LM-79-08 report at T=0 and at T=6000 hours with a summary table showing the percent lumen output change and percent input power change.
      2) LM-80-08 test data for the LEDs at the three temperatures per LM-80-08. Provide extrapolation data using an exponential decay function to show the output at 50,000 hours. Provide the Ts value from the LM-79-08 and where the point falls in relation to the LM-80-08 extrapolated data. Interpolate between the LM-80-08 data for the Ts temperature.

B. Sustainable Design Submittals:
   1. Product Data for Credit IEQ 4.2: For paints and coatings, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4.2: For paints and coatings, documentation indicating that products comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers.”
   3. Refer to Section 018113 "Sustainable Design Requirements” for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

C. Samples for Verification: For each type of luminaire.
   1. Include Samples of luminaires and accessories to verify finish selection.

D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing laboratory providing photometric data for luminaires.
B. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
C. Product Certificates: For each type of luminaire.
D. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency
E. Sample warranty.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. LEDs: Provide One for every 100 factory assembled replacement LED package with electrical leads. Furnish at least one of each type. May be unitized with power supply unit/driver.
3. Power Supply Units/ driver: One for every 100 of each type and rating installed. Furnish at least one of each type. May be unitized with LEDs.
4. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE
A. Institute for Electrical and Electronics Engineers (IEEE)
   1. IEEE PAR1789 - Recommending practices for modulating current in High Brightness LEDs for mitigating health risks to viewers
B. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
C. Provide luminaires from a single manufacturer for each luminaire type.
D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY
A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
B. Warranty Period: Five year(s) from date of Substantial Completion.
C. Warranty Period for Light Sources: Five year replacement material warranty on all light sources (LED package, LED array, or LED module) including, but not limited to the LED die, encapsulate, and phosphor for the LEDs lumen maintenance not achieving L70 after 50,000 hours.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 LUMINAIRE REQUIREMENTS
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by UL, ETL, CSA, or other qualified testing agency, and marked for intended location and application.
B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI.

C. Recessed luminaires shall comply with NEMA LE 4.

D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

E. Rated lamp life of 50,000 hours.

F. Lamps dimmable from 100 percent to 0 percent of maximum light output.

G. Internal driver.

H. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

2.3 LEDS

A. LED sources must meet the following requirements:

1. Operating temperature rating must be between -40°C and +50°C

2. Correlated Color Temperature (CCT):
   a. Nominal CCT: 2700 K (2725 ± 145)
   b. Nominal CCT: 3000 K (3045 ± 175)
   c. Nominal CCT: 3500 K (3465 ± 245)
   d. Nominal CCT: 4000 K (3985 ± 275)
   e. Nominal CCT: 4500 K (4503 ± 243)
   f. Nominal CCT: 5000 K (5028 ± 283)
   g. Nominal CCT: 5700 K (5665 ± 355)
   h. Nominal CCT: 6500 K (6530 ± 510)
   i. Du’v’ tolerance of 0.001 ± 0.006

3. Color Rendering Index (CRI): greater than or equal to 80.

4. Luminaire manufacturer must submit reliability reports indicating that the manufacturer of the LED (chip, diode, or package) has performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows:
   a. High Temperature Operating Life (HTOL)
   b. Room Temperature Operating Life (RTOL)
   c. Low Temperature Operating Life (LTOL)
   d. Powered Temperature Cycle (PTMCL)
   e. Non-Operating Thermal Shock (TMSK)
   f. Mechanical Shock
   g. Variable Vibration Frequency
   h. Solder Heat Resistance (SHR)

2.4 LED DRIVERS / POWER SUPPLYS

A. LED drivers must meet the following requirements:

1. Drivers must have a minimum efficiency of 85%.

2. Starting Temperature: -40°C.

3. Electrical Characteristics.
   a. Volts: as indicated on Luminaire Schedule.
   b. Phase: Single.
   c. Hertz: 60.

4. Power supplies can be UL Class I or II output.

5. Drivers must have a Power Factor (PF) of greater than or equal to 0.90.

6. Drivers must have a Total Harmonic Distortion (THD) of less than or equal to 20%.

8. Drivers must be Reduction of Hazardous Substances (RoHS) compliant.
9. Inrush current <2A
10. Sound rating: Inaudible in a 24 dB ambient.
11. Class P thermally protected.
12. Drivers with 0-10V dimming capability must be isolated and not allow current to leak between the power source and the 0-10V control circuit.

2.5 LED LUMINAIRE
A. Provide luminaires with integral LED thermal management system (heat sinking).
B. Luminaires shall be equipped with an LED driver that accepts 120V through 277V, 50hz to 60hz (UNIV). Component-to-component wiring within the luminaire will carry no more than 80% of rated current and be listed by UL for use at 600 VAC at 302°F/150°C or higher. Plug disconnects shall be listed by UL for use at 600 VAC, 15A or higher.
C. LED modules shall have a minimum L70 service life of 75,000 hours at 25°C ambient temperature and based on IESNA LM-80 methodology.
D. Provide luminaires with individual LED arrays/ modules and drivers that are accessible and replaceable from exposed side of the luminaire. Luminaires requiring removal or replacement of entire luminaire to access LEDs and drivers will NOT be accepted.
E. Luminaire efficiency shall be minimum of 70 lumens per watt.
F. Warranty: 5 year warranty covering the LED arrays, and LED drivers.
G. Continuous Flicker Free dimming range 100% to 0% measured relative light output.

2.6 MATERIALS
A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.
B. Steel:
   1. ASTM A 36/A 36M for carbon structural steel.
   2. ASTM A 568/A 568M for sheet steel.
C. Stainless Steel:
   1. Manufacturer's standard grade.
   2. Manufacturer's standard type, ASTM A 240/240 M.
D. Galvanized Steel: ASTM A 653/A 653M.
E. Aluminum: ASTM B 209.

2.7 METAL FINISHES
A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.8 LUMINAIRE SUPPORT
A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting not to exceed 2,500 hours of use for LED luminaries. When construction is sufficiently complete, clean luminaires used for temporary lighting.

3.3 INSTALLATION

A. Comply with NECA/IESNA-500, “Recommended Practice for Installing Indoor Commercial Lighting Systems.”

B. Comply with NECA 1.

C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

D. Install lamps in each luminaire.

E. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Provide support for luminaire without causing deflection of ceiling or wall.
   4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

F. Flush-Mounted Luminaire Support:
   1. Secured to outlet box.
   2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
   3. Trim ring flush with finished surface.

G. Wall-Mounted Luminaire Support:
   1. Attached to a minimum 20 gauge backing plate attached to wall structural members
   2. Do not attach luminaires directly to gypsum board.

H. Ceiling-Mounted Luminaire Support:
   1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 120 inches (6 m) in length.
I. Suspended Luminaire Support:
   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
   3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
   4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

J. Ceiling-Grid-Mounted Luminaires:
   1. Secure to any required outlet box.
   2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
   3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

L. Light Track: Support track on maximum of 4 foot centers.

3.4 IDENTIFICATION
A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL
A. Perform the following tests and inspections:
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
      a. If 0-10V dimming does not perform to expectations, the contractor shall provide low pass filters at the 0-10V source to remedy performance issues.
   2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

D. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

E. Advance Notice: Give dates and times for field tests.

F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
   1. Corroded Fixtures: Replace during warranty period.

3.6 STARTUP SERVICE
A. Clean luminaires internally and externally after installation. Use methods and materials recommended by manufacturer.
3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer’s authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

B. Adjust aimable luminaires according to the directions shown on lighting drawings or per Owner’s direction.

3.8 INTERIOR LUMINAIRE SCHEDULE

A. See drawings for Luminaire Schedule.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. The work in this section includes furnishing and installing the following major elements, components, and associated accessories:

1. Interior luminaires
2. Fixture finishes
3. Light sources, lamps
4. Lampholders
5. Ballasts, transformers and drivers
6. Luminaire accessories

B. Related sections.

1. Division 00 – Procurement and Contracting Requirements
2. Division 01 – General Requirements
3. Division 09 – Finishes (including field painting of luminaires)
4. Division 11 – Equipment (including Theater, Stage and Audio-Visual Equipment)
5. Division 26 – Electrical (including all Sections under Division 260000 related to electrical devices for lighting).
6. Division 27 – Communications
7. Division 28 – Electronic Safety and Security

1.2 REFERENCES

A. Refer to Division 01 for general project references and standards.

B. All sections under Divisions of the American National Standards Institute (ANSI) related to electrical devices for lighting

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESA) Standard 90.1

D. Electrical Testing Laboratories, Inc. (ETL)

E. Illuminating Engineering Society of North America (IESNA)

F. International Energy Conservation Code (IECC)

G. National Electrical Code (NEC)

H. National Electrical Contractors Association (NECA)

I. National Electrical Manufacturers Association (NEMA)
1.3 SYSTEM DESCRIPTION

A. Performance Requirements

1. Contractor shall provide and install all components necessary for a complete working luminaire or luminaire system.
2. Existing light fixtures in the Valade Theater shall be inspected and re-used where possible.

1.4 SUBMITTALS

A. Refer to Division 01 – Administrative Requirements for project submittal procedures.

B. Provide the required number of submittals promptly and deliver through appropriate channels, leaving sufficient time for adequate review and possible re-submittals without jeopardizing project schedule.

1. Allow a minimum of ten (10) working days for the Lighting Consultant to review a submittal or re-submittal.

C. Contractor is responsible for verification of all actual field dimensions, quantities, coordination, and compliance with contract documents.

D. No release of orders for lighting equipment shall be made until review of submittals is complete.

E. Contractor-originated submittals: The submittals should demonstrate that the Contractor has coordinated the details of the equipment with the manufacturer including the mounting requirements, the architectural conditions, and the electrical requirements, as well as verified any recent changes in equipment availability.

1. Copies of the Lighting Designer’s or Architect’s construction documents cut sheets are not acceptable. The Contractor and/or the Contractor’s supplier shall provide their own submittal information for review.

F. Submit an indexed list of fixture types and quantities and catalog cuts for all product data. Manufacturer’s product data shall be marked clearly to indicate all technical information that indicates conformance to all specified requirements in contract documents. Product data shall include, but not be limited to, the following information:

1. Manufacturer’s catalog sheets of standard fixtures, indicating materials, gauges, dimensions, standard finishes available, weights, label by Underwriters’ Laboratories Inc. (UL) or an equivalent organization acceptable to the jurisdictional authority.
2. Notation of any variation from the specified product. This includes manufacturer initiated revisions or replacements of the specified product.
3. Photometry: Candlepower curves and/or other photometric performance data from the manufacturer’s catalogue sheets or printout of the IES file
4. Complete LED driver/power supply information as applicable to each fixture type. Submittal is to include the ballast, transformer or driver/power supply manufacturer name, part number and electrical specifications, including operating frequencies.
driver/power supply information shall also include corresponding compatible dimming devices, if dimming is required.

5. For lighting fixtures or components with cooling fans, or other potential sources of noise, submittal information shall include measured noise output in decibels (dB).

6. Manufacturer’s catalogue sheets for all specified accessories.

7. An inventory of all other equipment to be supplied including types, quantities, and reference to applicable drawings and schematics.

8. The equipment manufacturer shall provide additional information or demonstrations as required by the Owner or Architect to show conformance with Part 2 of this Specification. The additional information or demonstrations shall only be required prior to submittal final approval and by written notification from the Architect, or should product delivered to the job site be different from materials described in final submittals or published product literature. All demonstrations shall be at a location and time and in a manner chosen by the Owner.

G. Submittals shall be reviewed according to scope of work.

1. The Lighting Consultant shall review only the fixture types within their scope of work. Those types are designated in the fixture schedule and on the drawings with the prefix “L”.

2. Provide fixture submittals/shop drawings for all fixtures in the scope of work concurrently as one complete package. Return submittals shall be in one complete package containing only the fixtures still needing review.

3. Incomplete or partial submittals/shop drawings shall be returned without review.

H. Shop Drawings

1. Provide shop drawings for all nonstandard fixture types and configurations.

2. Provide dimensioned line drawings for these fixture types:
   a. Type L100 series
   b. Type L101 series

3. Shop drawing submittals shall include:
   a. One paper copy of the complete, fully dimensioned fixture drawings including all major components and details of fabrication.
   b. An electronic copy of the shop drawings in PDF scalable and printable format.
   c. Related architectural schematics with plans, sections and details indicating assembly, structural coordination, and installation of components.
   d. Inventory of all equipment to be supplied including types, quantities and reference to applicable drawings and schematics.
   e. Approximate weight of fully assembled fixture configurations.
   f. A complete finish schedule indicating the finish of all visible parts.

I. Light Fixture Mock-ups

1. Provide mock-ups of the light fixture types as listed below for aesthetic and functional approval by the Architect. Provide mock-ups after submittal review but prior to purchase.
INTERIOR LUMINAIRES

of fixtures. Coordinate with the architectural requirements of the mock-up as listed in Specification Section 014339. After the mock-up is approved, it will be an example for all other fixtures of the same type. Provide the following mock-ups

a. Type L100 (1) 4ft sample, including fixture and mounting accessories. Purpose of the mockup is to review the lighting effect and the appearance of the donor wall signage. Results of mockup may affect fixture location, accessories and/or fixture specification.

b. Type L150 (1) sample, including fixture and mounting accessories. Purpose of the mockup is to review the appearance of the fixture housing with the uneven wall treatment in the perimeter walls of the proscenium theatre. Results of mockup may affect fixture location, accessories and/or fixture specification.

c. Type L151 (1) sample, including fixture and mounting accessories. Purpose of the mockup is to review the aesthetic integration of the fixture housing with the vertical wood rods at the perimeter walls of the Valade Theatre. Results of mockup may affect fixture location, accessories and/or fixture specification.

d. Type L500 (2) samples, including fixture and mounting accessories for each, (1) 4’x4’ paint sample using Scuffmaster GOH31845303 Ambient Design AD10341 paint and (1) 4’ x 4’ paint sample using Scuffmaster GOH3184300 Burnished Metallic BR002 paint sample. Purpose of the mockup is to review and conduct side by side comparison of how the two paint options will perform under the specified lighting application. Results of mockup may affect fixture location, accessories and/or fixture specification. Construction of paint sample mockup and confirmation of paint color to be coordinated with Hamilton Anderson Architects.

J. Manufacturer’s Instructions

1. Provide manufacturer’s instructions for proper storage, handling, protection, examination, preparation, and installation of product to the Contractor prior to installation.

K. Closeout Submittals

1. Coordinate with Division 01 – Execution Requirements.

L. Operation and Maintenance Data

1. Coordinate with Division 01 – Facility Operation.

M. Substitutions

1. The identification and submittal of fixtures proposed as substitutions shall be in accordance with Part 2 of this specification section, and Division 01 – Product Requirements, and Bidding and Contracting Requirements.

2. The Owner / Architect is final authority concerning whether a proposed substitution is acceptable.

3. Submittals for fixtures proposed as substitutions shall meet the submittal requirements listed above, and the additional submittal requirements listed below:

a. The deadline for submittals for proposed substitutions shall be the earliest date determined by either:
1) The deadline established in Division 01 of this specification.

2) A date early enough to meet construction schedule requirements including time for substitutions submittal reviews. The minimum time allowance for substitutions submittal reviews shall be the time allotted for reviews of named fixture submittals plus an additional ten (10) working days.

b. All proposed substitutions shall be included in a single submittal package.

c. Any fixture that differs in any manner from that scheduled by manufacturer’s name shall be marked "exception", and exact differences shall be clearly indicated.

d. Associated unit cost credits to the owner for the proposed substitution shall be identified.

e. Photometry from an independent testing laboratory calculated according to IESNA standards is required.

1) Photometry shall include at a minimum:
   a) Candlepower distribution curve and table printed on paper. Data in table shall have vertical angles no greater than 10° increments, (5°, 15°, and 25° etc.). All asymmetric distributions shall have quadrants represented in 22.5° increments, (parallel, 22.5°, 45° ... normal), or sufficient increments to fully describe asymmetric light distribution.

f. Samples shall be required for all nonscheduled manufacturers that are submitted with insufficient data. Samples shall be provided for any proposed substitution upon request of the Architect.

g. Calculations of light levels produced by the substituted fixtures shall be required. Calculations shall:

1) Be performed using a recognized industry standard computerized lighting program. Acceptable software for computerized lighting programs includes, but is not limited to AGI by Lighting Analysts, Inc.

2) Be presented as a point-by-point grid of maintained footcandle levels taken at the horizontal plane at task. The grid shall be overlaid graphically on a to-scale light fixture layout with clearly identified fixture types.

3) Include the total Light Loss Factor used and a list of the individual loss factors in its composition.

4) Include an indexed list of the electronic photometry files used to represent the light fixtures.

5) Include an indexed list of the light fixture heights used in the calculation.

6) Include an indexed list of the lamp lumens and fixture wattages used in the calculation.

4. All additional expenses of any kind with respect to substitution(s) shall be born by the Contractor/Bidder. This shall include, but not be limited to, all fees and expenses incurred by the Architect and other related Consultants for evaluation of the substitution and
subsequent integration into the project, should the substitution be taken; and/or additional costs of other contractors related to the substitution(s).

1.5 QUALITY ASSURANCE

A. Qualifications

1. The manufacturer shall own and operate his/her own shop for fabrication of architectural luminaires and be regularly engaged in the fabrication and installation of such equipment. Fabrication of such equipment shall comprise no less than 90% of the manufacturer's business.

2. The Manufacturer shall have been engaged in the fabrication of the above equipment for at least the past 5 years

B. Regulatory Requirements

1. All luminaires shall be included in a list published by a National Recognized Testing Laboratory acceptable to the authority having jurisdiction and concerned with product evaluation such as Underwriters Laboratory (UL) or ETL.

1.6 DELIVERY, STORAGE & HANDLING

A. Delivery, storage and handling shall be coordinated with the General Contractor and shall meet all requirements described in Division 01 – Product Requirements.

B. Packing, Shipping, Handling & Unloading

1. Equipment shall be individually wrapped and sealed and substantially crated for shipment. All handling and shipping shall be performed in accordance with manufacturer’s recommendations. Store products in unopened cartons in a protected location.

2. All shipping costs to the job site are the responsibility of the Contractor. The shipping method/company is at the discretion of the Contractor in order to facilitate Acceptance at Site.

C. Acceptance at Site

1. The Contractor shall be responsible for acceptance of lighting equipment at the jobsite, confirming that all quantities and counts are correct and for keeping accurate logs and records of such information. Logs and records shall include but not be limited to date of shipment, date of acceptance at the jobsite, name and signature of individual accepting equipment at the jobsite, location of storage area, and confirmation of quantity counts listed on bills of lading. A copy of the shipping invoice or bill of lading shall be kept with each log entry of acceptance at the jobsite. Logs and records shall be made available to the Owner immediately upon request.

D. Storage and Protection

1. Upon delivery, the materials shall be stored under cover in a dry and clean location, off the ground. Delivered materials which are damaged or otherwise not suitable for installation shall be removed from the job site and replaced with acceptable materials.
2. Replace at no expense to the Owner, all equipment and materials which are damaged during storage or handling.
3. Delivery of material shall be scheduled to reduce on-site storage time required.
4. Refer to Division 01 for additional storage and protection requirements.

1.7 PROJECT / SITE CONDITIONS

A. Environmental Requirements

1. Verify all conditions at jobsite. Promptly report variations and obstructions to the Owner. All additions and or corrections shall be requested prior to fabrication.
2. Confirm all ceiling depths and ceiling thicknesses to insure that recessed fixtures can be installed in all ceiling conditions prior to order of the fixtures. After confirmation with the Architect, order modified fixtures for variations in ceiling depths or ceiling thicknesses.
3. The Contractor shall document the locations and condition of the existing light fixtures that shall be removed, stored and re-used prior to removal of the light fixtures to ensure the fixtures are re-installed in the same location.

B. Field Measurements

1. Where possible, field measurements shall be taken prior to installation preparations to ensure proper fitting of work.

1.8 SEQUENCING AND SCHEDULING

A. The Contractor shall provide a schedule of milestone completion dates for specific areas required to be completed prior to installation of equipment provided under this section to the General Contractor. These completion dates shall describe the required condition and level of finish required of each space.

1. The installation of the lighting equipment shall not occur until all painting in the area has been completed.
2. The installation of any lighting components sensitive to construction debris and dust shall not be installed until all debris and dust has been removed.

1.9 WARRANTY

A. Refer to Division 01 – Execution Requirements.

B. Contractor shall provide his/her own warranties as well as factory warranties. All equipment and labor in this contract shall be free from defects in products or workmanship for at least one year after date of acceptance of installation by Owner, unless otherwise noted or approved by Owner.

1.10 SYSTEM STARTUP, OWNER’S INSTRUCTIONS & COMMISSIONING

A. Coordinate with Division 01 – Execution Requirements and Facility Operation.

B. Instruction shall be provided to the Owner for proper relamping or replacing LED module procedures for all luminaires.
1.11 MAINTENANCE

A. Extra Materials
   1. Coordinate with Division 01 – Execution Requirements.

B. Maintenance Service
   1. Lighting system maintenance shall be in accordance with Division 01 – Facility Operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. For the purpose of establishing minimum functional and aesthetic criteria, product manufacturers have been indicated in the Interior Light Fixture Schedule.

B. Substitutions shall be in compliance with Division 1 – Product Requirements.

C. Fixture groups by the same manufacturer
   1. All products of the same specified type shall be by the same manufacturer.
   2. Each fixture group listed below shall be by the same manufacturer and from the same product line by that manufacturer:
      a. Group 1: Type L100 series
      b. Group 2: Type L101 series

2.2 MANUFACTURED UNITS

A. Fixture types are indicated by alphanumeric designations.

B. Provide all products with UL Label for the appropriate mounting conditions or with equivalent label by another National Recognized Testing Laboratory acceptable to the authority having jurisdiction.

C. Voltage is as specified in the Interior Lighting Fixture Schedule. Lamps shall be operated at no greater than their rated voltage.

D. In all cases where a device or a part of the equipment is referred to in a singular manner in the contract documents, it is intended that such reference shall include and apply to as many devices as are required to complete the installation.

E. Provide lighting fixtures new and complete with mounting accessories, junction boxes, trims and lamps.
   1. Provide lamps indicated on the Interior Lighting Fixture Schedule, or if not indicated, as recommended by the fixture manufacturer. Lamps shall be compatible with the respective fixture in all cases.
2. Fixture Type catalogue numbers do not necessarily denote required mounting equipment or accessories. Provide all appropriate mounting accessories for mounting conditions. For example, include plaster frames for plaster ceiling.

F. Fixture mounting shall carry the weight of the fixture to the building construction, clear of ducts or pipes.

G. Ball swivels and cable end hardware shall be concealed with sleeves.

H. Seismic Restraints

1. All pendant mounted fixtures shall have secondary seismic restraints from the mounting canopy to the main body of the fixture. Manufacturer shall provide detail drawings of method of seismic restraint for approval by Architect.

I. Recessed and pendant mounted fixtures shall have leveling provisions.

J. All recessed fixtures shall have the appropriate NEMA-Type frame that is compatible with the ceiling type specified by the Architect.

K. All mounting frames installed in damp locations or in plaster ceilings shall be galvanized.

L. Fixtures in non-accessible ceilings shall have accessible junction boxes, ballasts, and transformers through fixture apertures or in remote accessible locations.

M. All fixtures shall be free of inappropriate light leaks.

N. No metal clips, screws, angles, etc. shall be visible when the fixture is viewed from below.

O. Die casts shall be smooth, free of pits, grooves, and imperfections.

P. Spinnings shall be smooth and clean with finished edges, and free of spinning lines.

Q. Fixtures shall be ventilated for proper operation.

R. Recessed fixtures shall have integral thermal protection.

S. All adjustable fixtures shall have locking rotation and tilt devices.

2.3 COMPONENTS

A. Light Sources

1. LIGHT EMITTING DIODE (LED)

   a. LED sources shall be integrated in luminaire with Correlated Color Temperature of 3000K and Color Rendering Index (CRI) exceeding 90.

   b. The LED shall emit no UV or IR.

   c. The LED shall deliver average lumen maintenance of 70% through 50,000 hours minimum under typical conditions. Proper current de-rating shall be observed to maintain junction temperature below the rated maximum.
d. LED modules in the same L series fixture type shall have consistent color. Excessive color variation observed by Architect shall be replaced by the Contractor at no additional expense to the Owner.

2. Replacement of Lamps in Existing Light Fixtures
   a. Lamps in existing light fixtures shall be replaced with new lamps with Correlated Color Temperature of 3000K and Color Rendering Index (CRI) exceeding 90.

B. Lampholders
   1. Lampholders shall hold lamps securely to prevent damage caused by normal vibrations and maintenance handling.

C. Reflector Cones
   1. Cone flange shall be formed as an integral part of cone and shall have identical appearance as inner cone unless otherwise indicated. Flange overlap shall have a perpendicular orientation to cone and shall have adequate width to cove ceiling opening with no visible light leaks.

D. Light Emitting Diode (LED) drivers
   1. LED power supplies and dimming devices shall have short circuit, overload, and overheating protection.
   2. LED power supplies, LED dimming devices, and LEDs or fixture-integrated LEDs shall each be compatible with the other LED devices to which they are connected. Inter-compatibility of LED devices shall be as determined by the manufacturers of those devices.
   3. LED power supply and LED dimming devices provided shall be compatible with the dimming control system.
   4. Power supply output and secondary load wiring size shall be adjusted to accommodate for voltage drop over the entire length of the run.
   5. Dimming range shall be 10 – 100% unless otherwise indicated in the Light Fixture Schedule.
   6. Driver shall be capable of operating LED at any light level within the dimming range. This shall be accomplished without first flashing.
   7. Light level output shall be continuous, even, and flicker-free over the entire dimming range.

E. Housings
   1. Provide safety devices for removable fixture elements, (cones, louvers, lenses, etc.). Safety device shall support element while out of normal operating position and be removable. Safety device shall not interfere with normal operation of fixture.

F. Louvers, baffles, diffusers, lenses
   1. Fixtures with baffles/louvers riveted or welded to the housing are not acceptable.

2.4 ACCESSORIES
   A. Provide all individual light fixtures with accessories as listed in the Interior Light Fixture Schedule
2.5 FIXTURE FINISHES

A. Fixture finishes shall be coordinated with the General Contractor and shall meet all requirements described in Division 09 – Paints and Coatings.

B. Powder-coat paint

1. Powder coat paint shall be factory applied.

C. Self-flange cones shall be factory painted, not field painted, unless otherwise noted in Interior Lighting Fixture Schedule.

D. All color finishes shall be approved by the Architect.

2.6 EXISTING LIGHT FIXTURES

A. The condition of existing light fixtures shall be reviewed on site by the Contractor. This includes inspection of fixture body, lenses, wiring, mounting, ballast, transformer or driver. Contractor shall determine if existing light fixtures function adequately and safely and can be re-used.

B. Contractor shall document and report light fixtures that can and cannot be re-used. Existing light fixtures which cannot be re-used shall be replaced with new, similar type light fixture.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Review each luminaire to determine suitability for lamps specified.

B. The Contractor shall verify the site conditions for suitability of installation. If errors or defects exist in luminaire mounting locations, the luminaires shall be withheld from installation until the situation is remedied.

C. Confirm all ceiling depths and ceiling thicknesses to insure that recessed fixtures can be installed in all ceiling conditions prior to order of the fixtures. After confirmation with the Architect, order modified fixtures for variations in ceiling depths or ceiling thicknesses.

3.2 INSTALLATION

A. Light fixture installation shall be coordinated with the General Contractor and shall meet all requirements described in Division 01 – Execution Requirements.

B. Light fixtures shall be installed as located on architectural plans and reflected ceiling plans, as zoned for control per electrical drawings and per approved shop drawings.

C. Light fixtures shall be installed in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, applicable NECA Recommended Practices, NEMA standards, and recognized industry practices.
D. Verify locations and spacing of lighting fixtures with drawings and notify Architect of any variance or conflict between the plans and field conditions. Do not proceed until conflict has been resolved.

E. Work shall be coordinated with other trades. Lighting fixture locations shall have priority over location of ducts, diffusers, sprinklers, smoke detectors and other non-structural obstructions.

F. Structural support of all fixtures shall comply with the applicable building codes having jurisdiction over the project.

G. Provide all necessary hardware and blocking to ensure that fixtures are mounted level, true, square, plumb, and in proper alignment.

H. Fixtures installed in suspended T-bar ceilings shall be equipped with T-bar clips tested for use with that ceiling system. Clips shall be securely fastened to suspended T-bar ceiling system framing members.

I. All fixtures shall be unpacked, lamped if necessary, accessorized and installed for the final adjustment by the Contractor under the direction of the Architect.

J. Luminaires shall be bonded to branch circuit equipment-grounding conductor.

K. Recessed Fixtures

1. All fixtures shall be installed with the bottom of the fixture housing aligned with the finished ceiling line unless otherwise noted in manufacturer’s installation instructions.

2. Ceiling insulation shall be a minimum of 3” away from the light fixture unless the fixture is Insulated Ceiling rated.

3. Holes shall be cut to exact fixture size so that no gaps shall be present when trims or cones are installed.

4. Round holes in acoustical tile ceiling shall be cut using adjustable diameter cutter on slow speed drill press.

5. Installation of trims shall be tight with no gaps or light leaks. Reflector cones, baffles, aperture plates and decorative elements shall be installed after completion of plastering, ceiling tile work painting and general cleanup of areas.

L. Linear Fixtures

1. Linear fixtures, surface mounted or suspended, shall not have more than ¼” variation in alignment for any 16’ run.

2. In spaces with parallel rows of suspended fixtures all cord feeds shall be installed with the same orientation.

3.3 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect each fixture for proper connections and operation.

B. Perform testing of operation of temporary or emergency power systems.

C. Verify that all lenses, louvers, baffles, fixture trim cones, diffusers and other parts are thoroughly cleaned in a manner recommended by the manufacturer.
D. Replacement of blemished parts: Any luminaire components, including but not limited to reflector cones, lenses and louvers, that have been over-sprayed or damaged by paint or other materials bonding permanently to surfaces shall be replaced at no cost to the Owner.

3.4 ADJUSTING

A. All adjustable architectural luminaires shall be focused, aimed or otherwise adjusted by the Contractor under the direction of the Architect during the final adjustment.

1. Lighting adjustment shall take place after the project’s amenities, such as furniture, artwork, graphics, signage, planting and final finishes, have been installed and after any system commissioning has occurred.

2. The Contractor shall provide personnel to work with the Architect’s personnel to adjust the lighting fixtures. The Architect shall direct representative examples of fixture adjustment for the Contractor, but shall not adjust each individual fixture. The Contractor shall be responsible for adjusting all fixtures.

   a. Contractor’s personnel shall be familiar with the installed lighting equipment and the lighting controls for the site.

   b. Lighting fixture adjustments shall occur at night in daylit areas.

   c. The focusing and checkout of the lighting requires that all work lights be turned off in the area of the lighting adjustments.

3.5 CLEANING

A. Coordinate with Division 01 – General requirement.

B. The Contractor shall thoroughly clean all existing light fixtures that shall be retained and re-used.

3.6 DEMONSTRATION

A. Maintenance personnel shall be advised on replacing LED modules and/or re-lamping and maintenance procedures and be given by the Contractor a list of light sources required for the light fixtures on the project.

3.7 PROTECTION

A. Light fixtures, once installed, shall be protected from damage during the remainder of construction period.

B. The Contractor shall protect the existing light fixtures that shall be retained and re-used from damage.

   1. If necessary to protect the existing light fixtures, the Contractor shall remove, store and re-install light fixtures when the site is ready.
3.8 SCHEDULE AND PRODUCT DATA

A. For additional information, refer to the Interior Light Fixture Schedule in Electrical drawings and Product Data Sheets (catalog cuts) following the end of this Section.

END OF SECTION 26 52 01
SECTION 265219
EMERGENCY AND EXIT LIGHTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Emergency lighting units.
   2. Exit signs.
   4. Luminaire support components.

1.3 DEFINITIONS
A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
D. Fixture: See "Luminaire" Paragraph.
E. Lumen: Measured output of lamp and luminaire, or both.
F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. Include data on features, accessories, and finishes.
   8. Include physical description of the unit and dimensions.
   9. Battery and charger for light units.
10. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
11. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
   a. Manufacturers’ Certified Data: Photometric data certified by manufacturer’s laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
B. Refer to Section 018113 “Sustainable Design Requirements” for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing laboratory providing photometric data for luminaires.
B. Product Certificates: For each type of luminaire.
C. Product Test Reports: For each luminaire for tests performed by manufacturer and witnessed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers’ codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
   3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
   4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE
A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer’s laboratory that is accredited under National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products and complying with applicable IES testing standards.
B. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY
A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Lamp Base: Comply with ANSI C81.61.

F. Bulb Shape: Complying with ANSI C79.1.

2.2 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.
   1. Emergency Luminaires: As indicated on Interior Lighting Fixture Schedule, with the following additional features:
      a. Internal emergency power unit.
      b. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.
      c. UL 94 flame rating.

B. Emergency Lighting Unit:
   1. Emergency Lighting Unit: As indicated on Interior Lighting Fixture Schedule.
   2. Wall with universal junction box adaptor.
   3. UV stable thermoplastic housing
   4. Two LED lamp heads.
   5. Internal emergency power unit.

2.3 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

2.4 MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:
   1. Smooth operating, free of light leakage under operating conditions.
   2. Designed to permit relamping without use of tools.
   3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Conduit: Electrical metallic tubing, minimum 3/4 inch (21 mm) in diameter.

2.5 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm)

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA/IESNA-500, “Recommended Practice for Installing Indoor Commercial Lighting Systems.”

B. Comply with NECA 1.

C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

D. Install lamps in each luminaire.

E. Supports:
   1. Sized and rated for luminaire and emergency power unit weight.
   2. Able to maintain luminaire position when testing emergency power unit.
   3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
   4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:
   1. [Attached to structural members in walls] [Attached to a minimum 20-gage backing plate attached to wall structural members] [Attached using through bolts and backing plates on either side of wall] <Insert means of attachment>.
   2. Do not attach luminaires directly to gypsum board.

G. Suspended Luminaire Support:
   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
   3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and [tubing or rod] [wire support] for suspension for each unit length of luminaire chassis, including one at each end.
   4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Ceiling Grid Mounted Luminaires:
   1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION
A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL
A. Perform the following tests and inspections:
   1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
B. Luminaire will be considered defective if it does not pass operation tests and inspections.
C. Prepare test and inspection reports.
D. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
E. Advance Notice: Give dates and times for field tests.
F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
G. Corroded Fixtures: Replace during warranty period.

3.5 CLEANING
A. Clean luminaires internally and externally after installation. Use methods and materials recommended by manufacturer.

3.6 INTERIOR LUMINAIRE SCHEDULE
A. See drawings for Luminaire Schedule.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
1. Provide all electrical services, materials, labor and installation suitable to accommodate the installation and complete function of the Division 11 theatrical systems equipment specified in other Sections, including:
   a. Section 116133 – Theatrical Rigging
   b. Section 116135 – Stage Extension - Orchestra Pit Lift System
   c. Section 116163 – Theatrical Lighting Dimming and Control
   d. Section 116173 – Theatrical Lighting Fixtures
   e. Section 126100 – Fixed Auditorium Seating
2. Coordinate Theatrical Systems-related electrical materials installation with the Theatrical Systems drawings.
3. Provide Theatrical Systems-related electrical materials and methods in accordance with all requirements and related sections of Division 26 and as detailed herein. In event of conflict, the stricter requirement will prevail.
4. Provide all Theatrical Systems junction boxes, pull boxes, terminal cabinets, cable trays, cable hooks, conduit, enclosures, standard outlet and device back boxes, and other electrical materials and hardware for a complete Theatrical Systems electrical infrastructure as specified herein and in quantities and location as shown on the Theatrical Systems and Electrical drawings.
5. Provide all disconnects, panelboards and company switches for Theatrical Systems Equipment as specified herein and in quantities as shown on Electrical drawings.
6. Provide test reports and verification that wiring installations comply with applicable standards and the requirements set forth in the Division 11 Theatrical Systems documents and by the equipment manufacturers.
7. Under work of this Section, related to Section 116133 – Theatrical Rigging Systems (TR-series Drawings)
   a. Coordinate with the work of Section 116133 - Theatrical Rigging
   b. Provide all conduit, wire, wire pulling and termination for theatrical rigging equipment.
   c. Provide terminations for motorized theatrical rigging systems motion control racks and devices; low voltage termination will be terminated under the direct supervision of the Theatrical Rigging contractor.
   d. Provide all local motor disconnects as required to complete system in a code compliant manner.
   e. Provide and terminate all wiring and receptacles required for theatrical rigging system power as indicated on drawings.
   f. Provide terminations for all system electrical safety devices.
8. Under work of this Section, related to Section 116135 – Stage Extension - Orchestra Pit Lift System (TE-series Drawings)
   a. Coordinate with the work of Section 116135 - Stage Extension - Orchestra Pit Lift System.
   b. Provide all conduit, wire, wire pulling and termination for motorized theatrical stage lift equipment.
c. Provide terminations for motorized theatrical stage lift system motor control racks and devices, low voltage termination will be terminated under the direct supervision of the Theatrical Machinery contractor.

d. Provide all local motor disconnects as required to complete system in a code compliant manner.

e. Provide terminations for all system electrical safety devices.

9. Under work of this Section, related to Section 116163 - Theatrical Lighting Dimming and Control Systems (TL-series Drawings)
   a. Coordinate with the work of Section 116163 - Theatrical Lighting Dimming and Control systems.
   b. Provide all conduit, wire, and wire pulling for theatrical lighting systems.
   c. Provide and terminate all wiring and receptacles required for the Theatrical Lighting system "LS" power system as indicated on drawings.
   d. Provide terminations for theatrical lighting system racks and devices; low voltage termination will be terminated under the direct supervision of the Theatrical Lighting contractor.
   e. Provide interface(s) as necessary to dim architectural LED lighting fixtures within the performance spaces with input control signal (DMX control protocol) provided under section 116163.
   f. Provide emergency transfer panel(s) to transfer designated architectural house lighting branch circuits, as determined by the Electrical Engineer, from normal to emergency power.
   g. Provide emergency power branch circuits to designated architectural LED lighting control signal interface(s) provided under Section 116163.

10. Under work of this Section, related to Section 126100 – Fixed Auditorium Seating (TS-series Drawings)
   a. Coordinate with the work of Section 126100 – Fixed Auditorium Seating.
   b. Provide all conduit, wire, wire pulling, floor junction boxes and terminations for fixed auditorium seating aisle light fixtures.
   c. Layout and install underfloor and in-slab conduit and aisle light junction boxes based on the seating layout shop drawings for Section 126100 – Fixed Auditorium Seating with review action “No Exceptions” or “Make Corrections Noted”.

11. Delegated Design:
   a. Refer to Section 260529 – Hanger and Support for Electrical Systems
   b. Refer to Section 260548 – Electrical Vibration and Noise Control
   c. Provide design of the means of fastening, suspending and supporting of the work of this Section.

B. Products Installed But Not Supplied Under This Section
   1. Related to Section 116133 - Theatrical Rigging Systems
      a. Install all Theatrical Rigging Systems line voltage and low voltage control equipment as furnished under Section 116133.
      b. Terminate all Theatrical Rigging System power disconnects and devices within equipment racks (including receptacles, etc.), as furnished under Section 116133.
      c. Install all Theatrical Rigging Systems specialty panel and device back boxes furnished by Division 11 where noted. Provide all required conduit, electrical hardware, and mounting brackets.

C. Related to Section 116135 – Stage Extension - Orchestra Pit Lift System
   1. Install all Stage Extension Lift line voltage and low voltage control equipment as furnished under Section 116135.
   2. Terminate all Stage Extension Lift System power disconnects and devices within equipment racks (including receptacles, etc.), as furnished under Section 116135.
3. Install all Stage Extension - Orchestra Pit Lift System specialty panel and device back boxes furnished by Division 11 where noted. Provide all required conduit, electrical hardware, and mounting brackets.

D. Related to Section 116163 - Theatrical Lighting Dimming and Control
   a. Receive, store and install dimmed and switched power distribution equipment and associated control equipment furnished under Section 116163.
   b. Receive, store and install all power and control distribution and connection devices furnished under Section 116163.
   c. Install all head-end control equipment furnished under Section 116163 under the direct supervision of the equipment manufacturer.
   d. Coordinate and install control signal interfaces provided under Section 116163 to transfer control signal for designated architectural LED lighting fixtures and drive all loads to full in the case of a loss of normal power.
   e. Install terminal boxes and terminate flexible multi-cable drops to fixed electric battens.

2. Related to Section 126100 – Fixed Auditorium Seating
   a. Receive, store, move to installation location and install transformers and proprietary power supplies related to aisle lights.
   b. Terminate aisle lighting fixtures furnished under Section 126100.

1.2 REFERENCES

A. Abbreviations and Acronyms
   1. The following abbreviations and acronyms are relevant to this Section and are in addition to those defined in Division 01 – General Requirements.
      a. A/R – As Required
      b. ATP – Acceptance Test Procedure
      c. AWG – American Wire Gauge
      d. Cat – Category
      e. CP – Connection Panel
      f. CWANA – Complete with all necessary accessories
      g. FAT – Factory Acceptance Test
      h. MCR – Motion Control Rack
      i. RF – Radio Frequency
      j. RU – Rack Unit. One Rack Unit equals 1.75 inches of vertical panel height.
      k. TSE – Theatre and Stage Equipment

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination
   1. Under work of this Section, coordinate the installation of all Electrical provisions for the Theatrical Systems and Equipment.
   2. Comply with “hold clear” requirements indicated in the Contract Documents for the Theatrical Systems and Equipment.

B. Pre-installation Meeting
   1. Refer to Division 01 – General Requirements for information regarding pre-installation meeting with General Contractor.

C. Sequencing
1. Install the theatrical systems wiring devices following completion of all painting and wet trade work in the area, and the area is continuously free of excessive water, dirt, dust and debris that may be harmful to installed equipment.

2. Sequence the work to comply with the equipment delivery, storage and handling requirements specified elsewhere in this Section.

3. Computer grade network components, rack processors and modules, and any other equipment sensitive to construction debris and dust shall not be installed until all debris and dust has been removed. Typical finished “office” cleanliness shall be required and must be continuously maintained in rooms in which computer grade equipment is to be installed.

4. Computer grade network components, rack processors and modules, and any other valuable equipment shall not be installed until equipment rooms are continuously secure.

5. The unpacking and installation of computer control consoles and peripheral devices shall not occur until the control room is continuously secure, free of dust and debris, and climate controlled.

6. Scheduling:
   a. Comply with the project schedule.
   b. Install, startup, test and commission the work of this Section in a timely manner to allow the work of the various Theatre and Stage Equipment Sections to proceed in conformance with their portion of the project schedule, including a reasonable allowance for the startup, testing, commissioning, and Acceptance Testing Procedures specified in those Sections.

1.4 SUBMITTALS

A. Submit information on materials being proposed in accordance with the requirements of Division 01 – General Requirements.

B. Product Data
   1. Submit for each product specified in this Section.

C. Shop Drawings
   1. Provide coordinated mounting detail drawings for all theatrical devices.
   2. Provide coordinated plan detail drawings showing all theatrical related MEP equipment regardless of its location.
   3. Provide coordinated section and elevation detail drawings showing all theatrical related MEP equipment in all theatrical systems equipment rooms, including but not limited to dimmer rooms, control rooms, projection rooms, theatrical audio video equipment rack rooms, etc.

D. Delegated Design Submittals
   1. Provide design of the means of anchorage, fastening, suspension and support of the work of this Section.
   2. Provide drawings and calculations meeting the review requirements of the authorities having jurisdiction, stamped and wet signed by a Professional Engineer licensed in the project jurisdiction for work of the specific type performed.

E. Site Quality Control Submittals
   1. Submit test reports for wire and cable installed under work of this Section.

F. Manufacturer Reports
1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements
   1. Theatre and Stage Equipment is classified according to its susceptibility to construction conditions that may affect its operation. Classes shall be defined by the following paragraphs.
      a. Class 1:
         1) Cable and distribution apparatus, structural elements, electrical back boxes, face plates, terminal boxes, and empty dimmer racks and empty equipment rack frames may be stored in weather-protected spaces under “normal” construction site conditions provided that no electronic components are contained within devices. Storage boxes shall be sturdy and well-sealed, and equipment shall be protected with imperforate inner plastic sheeting.
         2) Contractor may install this class of equipment in weather-protected spaces under “normal” construction site conditions provided that equipment is protected from dust and moisture by sturdy imperforate plastic sheeting and completely covered with corrugated cardboard held securely in place by tape with an acrylic adhesive that provides UV resistance, such as “blue painter’s tape”. Cardboard covers shall not be removed until area is broom cleaned. Under no circumstances shall equipment remain uncovered overnight during installation or while work which causes high dust or moisture levels in area of placement is taking place.
      b. Class 2:
         1) Control panels, dimmer modules, spare parts, test and other equipment (except as listed under Class 3) not subject to damage by concrete dust or dirt shall be stored and protected as specified herein for Class 1 devices.
         2) Contractor shall not install equipment in this class until area of installation is broom cleaned, “blown” clean with pressurized air, mopped, air conditioned and secure. Contractor may install control panels with electronic components under Class 2 conditions, but electronic components must be removed and not installed until area of installation meets Class 3 conditions.
      c. Class 3:
         1) Mixing and control consoles, computers, dimmer control electronics, filled equipment racks and other electronic equipment shall not be shipped to site until the rack and control rooms are finished, air conditioned, dust free, broom and mop cleaned, secure, and in all respects complete and ready for occupation.
         2) This class of equipment shall not be unpacked until the system is complete in all other respects. Under no circumstances may any equipment in this class be removed from the rack and control rooms into or through spaces that are not cleaned, air conditioned, and complete.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND COMPONENTS

A. Raceways
   1. Refer to Section 260533 – Raceways and Boxes for Electrical Systems, in addition to the following.
   2. Conduit and Fittings
      a. Provide electrical metallic tubing (EMT) conduit for all Theatrical Systems wiring with the following exceptions:
         1) PVC conduit is NOT acceptable, except within concrete slab.
3. Cable Trays
   a. General
      1) Provide cable trays, tray supports, and splicing hardware to accommodate cable runs as shown on theatre equipment drawings. Refer to sections 116163.
      2) Trays to be adequately mounted so that there is no visible deflection between supported sections.

4. Cable Hooks
   a. Cable hooks for temporary cable routing
      1) Provide one piece, non-metallic cable saddle rack, with three saddle hooks, 32" long x 3" wide x 5" deep.
      2) Provide location and quantity to accommodate cable runs as shown on the electrical drawings.
      3) Cable saddle rack shall be finished gray
      4) Cable saddle rack shall be by Underground Devices, Model 3SR3, or equal.

B. Boxes
   1. Refer to Section 260533 - Raceways and Boxes for Electrical Systems, in addition to the following.
   2. Pull and Junction Boxes
      a. Pull and junction boxes shall be as specified under 260533, Electrical Boxes, Pull and Junction Boxes.
   3. Theatrical Lighting Control Station (TC) back boxes
      a. Theatrical lighting control station back boxes shall be an extra deep masonry box with a minimum depth of 2-1/2" to accommodate electronics and connectors.
      b. Provide recessed outlet boxes so that the receptacle-outlet cover plate can be securely attached to the back box as intended by the receptacle-outlet cover plate manufacturer.
      c. Provide recessed outlet boxes so that the receptacle-outlet cover plate is flush with the final finished surface of the surrounding wall finish. Verify surface treatments with architect prior to installation.

C. Theatrical Systems Line Voltage Cable
   1. Provide only cable types specified in Electrical Documents. No substitutions allowed without written approval of the Architect, Theatre Consultant and specialized Theatrical Systems Manufacturer/Contractor.
   2. Size cables and wires to compensate for voltage drop in all line voltage cable runs so that voltage measured at each remote device is no less than 115V under a loaded condition with a 10 amp load.
   3. Cable splicing may only be used where cable lengths exceed available stock purchasable lengths or in relocating existing devices. Any cable splices must be fully insulated. Conductor counts of 8 or more conductors shall utilize a terminal strip with bussing straps.
      a. Crimped butt type splices are acceptable for conductor counts of less than 8 conductors.
      b. Wire nuts are not acceptable.
   4. The Architect, Theatre Consultant and specialized Theatrical Systems Manufacturer/Contractor shall be notified in advance of all splice locations for approval.

D. Theatrical Systems Control Cable
   1. General
      a. Provide only wire types specified in Electrical Documents and verified by Theatrical Systems Manufacturer/Contractor's shop drawings. No substitutions allowed without written approval of the Architect, Theatre Consultant and specialized Theatrical Systems Manufacturer/Contractor.
b. Wire types provided in Electrical documents represent the information available at the time of bid and are provided for development of conduit size requirement and bidding purposes. Determination of the final wire type is dependent on the proprietary systems of the successful Division 11 manufacturer. Do not purchase or install any Theatrical Systems control cable until shop drawings for these systems are approved.

c. All wire to be installed in conduit unless otherwise noted or by specific written agreement by Electrical Engineer. Should an exception be made allowing cable to be run outside of conduit, contractor shall provide appropriate plenum rated cable for approval by Electrical Engineer and Theatrical Systems Manufacturers.

d. Network cable runs shall be continuous. Cable splicing will not be acceptable.

e. All network cable runs must be confirmed. Lengths exceeding 250 feet (75M) shall be identified and run with fiber optic cable.

2. Network Cabling

a. Theatrical Lighting Control Network Cabling

1) The Theatrical Lighting Control systems network cable runs consist of copper twisted pair wiring or optical fiber for the transport of Ethernet protocol as indicated in the Theatrical Lighting System drawings and specifications.

2) Cabling shall include a 3 foot service loop at the field device and minimum 12 foot service loop at terminal panels/equipment racks.

3) Category 5e Network cabling lengths exceeding 250 feet shall be identified by contractor at the time of shop drawing submittal.

4) All Category 5e network runs exceeding 250 feet must be run via satellite network locations added to resolve over-length conditions. Fiber optic cabling may not be substituted unless specified otherwise.

5) All network cable runs shall be continuous. Cable splices, wire nuts, terminal strips, etc., are not acceptable.

b. Theatrical Rigging & Stage Lift Automation Control System Cabling

1) The Theatrical Rigging automation control systems network cable runs consist of copper twisted pair wiring or optical fiber for the transport of Ethernet protocol as indicated in the Theatrical Rigging control system drawings and specifications.

2) Cabling shall include a 3 foot service loop at the field device and minimum 12 foot service loop at terminal panels/equipment racks.

3) Network cabling lengths exceeding the Theatrical Rigging Automation System contractor's defined maximum length for each segment of the Theatrical Rigging Automation Control System shall be identified by contractor at the time of shop drawing submittal.

4) Network cable runs exceeding the Theatrical Rigging Automation System Contractor's defined maximum length for each segment of the Theatrical Automation Control System must be rerun to bring the lengths to below the required maximum cable length.

5) All network cable runs shall be continuous. Cable splices, wire nuts, terminal strips, etc., are not acceptable.

E. Wiring Devices

1. Refer to Section 262726 - Wiring Devices, in addition to the following

2. Provide Theatrical systems receptacles and other required wiring devices, complete with associated hardware and wall plates, as specified below. Verify cover plate finish color with the Architect.

3. Theatrical Lighting receptacles

a. Theatrical Lighting Fixture Circuit - Edison/Straight Blade Receptacle Types

1) Duplex 20 Amp 120V Edison receptacles shall be standard NEMA 5-20R configuration, 2-pole, 3-wire.

   a) Receptacles shall be Hubbell HBL8319C, or approved equal.
b) Plugs shall be Hubbell HBL8315C, or approved equal.

b. Theatrical Lighting Fixture Circuit - Twist-Lock/Locking Receptacle Types
   1) Single 20 Amp 208V Twist-Lock receptacles shall be standard NEMA L6-20R configuration, 2-pole, 3-wire.
   2) 3-phase 20 Amp 120/208V Twist-Lock receptacles shall be standard NEMA L21-20R configuration, 4-pole, 5-wire.

c. Theatrical Lighting System power receptacle-outlets "LS" – Edison/Straight Blade Receptacle Types
   1) Duplex receptacle outlets shall be standard NEMA 5-20R "Edison" straight blade U-ground, 20A/120V 2-pole, 3-wire devices
   2) Provide cover plate, with blue label for circuits marked “LIGHTING SYSTEM POWER" and indicate home run panel and circuit breaker number.

4. Theatrical Rigging receptacles
   a. Theatrical Rigging Chain Hoist power receptacle – Twist-Lock/Locking Receptacle Types
      1) 3-phase 30 Amp 120/208V Twist-Lock receptacles shall be standard NEMA L21-30R configuration, 4-pole, 5-wire
         a) Receptacle shall be Hubbell or equal
         b) Receptacle color shall be green.
      2) Receptacle to be fed from general power panels designated TMG-#
      3) Provide cover plate with label marked indicating home run panel and circuit breaker number.

5. Company Switches & Receptacles
   a. Provide Theatrical Systems company switch disconnects and receptacles as described herein and as shown on Electrical drawings.
   b. 60 Amp Theatrical Lighting / Theatrical Rigging company switch receptacles
      1) Company switch receptacle configuration shall be 120/208-volt 3-phase 4-wire & equipment ground 60-amp mechanically interlocked pin and sleeve receptacle provided with mating plug connector.
      2) Provide 60-amp Hubbell HBL560MI9W Receptacle and HBL560P9W Plug.
   c. 100 Amp Theatrical Lighting / Theatrical Rigging company switch receptacles
      1) Company switch receptacle configuration shall be 120/208-volt 3-phase 4-wire & equipment ground 100-amp mechanically interlocked pin and sleeve receptacle provided with mating plug connector.
      2) Provide 100-amp Hubbell HBL5100MI9W Receptacle and HBL5100P9W Plug.
   d. 200 Amp Theatrical Audio Video company switch disconnect
      1) Company switch shall be 120/208-volt 3-phase 4-wire & equipment ground 200-amp device with means of connection for both single pole E1016 compatible connectors and direct wire lugs in a connection chamber.
      2) Provide Lex Products CS-200F-C5DS1 or Union Connector CSC-2010-CSP.
         a) Provide isolated ground option.
   e. 400 Amp Theatrical Lighting company switch disconnect
      1) Company switch shall be 120/208-volt 3-phase 5-wire & equipment ground 400-amp device with means of connection for both single pole E1016 compatible connectors and direct wire lugs in a connection chamber.
      2) Provide Lex Products CS-400F-C6DS1 or Union Connector CSC-4020-CSP.
         a) Provide double neutral option.

F. Architectural Lighting Emergency Transfer Panels
   1. Provide an emergency transfer system to provide automatic transfer of designated architectural house lighting branch circuits from theatrical system power controls to emergency power upon loss of normal power.
   2. Refer to Electrical drawings for designation and quantity of emergency branch circuits. Emergency power source to be provided under Division 26.
3. Unit shall provide multiple 20A circuits and be compatible with single or three phase systems.
4. Unit shall provide continuous monitoring of normal and emergency power in order to activate automatic power transfer.
5. The unit shall be UL1008 listed.
6. The transfer switch shall be electrically operated and mechanically held.
7. Unit shall include a normally closed dry contact closure for fire alarm input.
8. Provide:
   a. Electronic Theatre Controls ELTS2, circuit quantity as listed on drawings.

PART 3 - EXECUTION

3.1 THEATRICAL SYSTEMS INSTALLATION

A. General
1. Comply with the requirements of Section 260500 – Part 3 – Execution for Electrical Systems, and the following more restrictive requirements for Electrical systems work related to Theatre and Stage Equipment systems infrastructure.
2. At theatrical function catwalks, lighting catwalks and similar theatrical purpose functional positions, coordinate locations of all Electrical installation with the “hold clear” zones for Theatre and Stage Equipment.
3. Install all dimmer racks, equipment racks, terminal boxes, cable trays, conduit, enclosures and wiring devices in conformance with the static load and seismic restraint requirements of all local and national building Codes applicable to the project.
4. No conduit or conduit supports are permitted on horizontal railings, on vertical hangers below 48 inches, overhead rigging grids, or across theatrical lighting positions.
5. Mount all theatrical systems devices as shown on the drawings. Where the Contractor may desire deviations from mounting methods shown on the drawings due to field conditions, submit a Request For Information (RFI) in conformance with Project procedures and obtain response before proceeding with the work.

B. Raceway, Conduit and Fittings
1. Unless otherwise indicated, for Theatre and Stage Equipment systems infrastructure, provide a conduit system of steel material.
2. Provide rigid steel conduit where exposed to physical damage.
3. Below slab-on-grade, at other underground locations, and embedded in concrete masonry units (CMU) provide:
   a. Rigid steel conduit (RSC) with bitumastic coating, or,
   b. PVC Coated Rigid Steel Conduit (CRSC), or,
   c. At other locations, provide electrical metallic tubing (EMT).
4. Install raceway free of dents, nicks, and burrs. Ream all cut raceway and raceway ends.
5. Provide conduit trade size as indicated, but not less than:
   a. For metallic conduit, ¾ inch trade size.
   b. For rigid non-metallic conduit, 1 inch trade size.

6. Wireways, Auxiliary Gutters and Associated Fittings
7. Install plumb and square.
8. Protect cables from damage from cover fastening screws.

C. Cable Trays
1. Install cable trays in conformance with NFPA 70 Articles 250 and 392, NEMA VE 2.
2. Install with sufficient space maintained about the cable trays to permit adequate access for installing and maintaining the cables. Install with a minimum clear distance of 3 feet on one side, and one foot above the top member of the cable tray to any obstruction above.
3. Provide cable trays, tray supports, and splicing hardware to accommodate cable runs as shown on theatrical drawings. Coordinate cable tray size and loading depth with the wiring requirements of the related theatrical drawings and Division 11 Section.

4. Provide drop-out fittings above equipment racks, and at other locations as required to maintain cable bend radius limits.

D. Outlet, Device, Pull and Junction Boxes, Terminal Cabinets
1. Comply with NFPA 70 Article 314 and the following:
2. Provide a pull box for any conduit run which is greater than 150 feet or where the run includes the equivalent of three 90 degree bends, including those bends located immediately at an outlet or fitting.
3. Label pull boxes with the system name and box circuit identification.
4. Indicate locations of pull boxes and terminal cabinets on Record Documents.
5. Recessed outlet boxes shall be installed as follows:
   a. Install recessed outlet boxes so that the receptacle-outlet cover plate can be securely attached to the back box as intended by the receptacle-outlet cover plate manufacturer.
   b. Install recessed outlet boxes so that the receptacle-outlet cover plate is flush with the final finished surface of the surrounding wall finish. Verify surface treatments with architect prior to installation.
   c. Install recessed boxes plumb, true, and slightly back of the final finished surface so the device cover can be installed tight to the finish surface.
6. Surface mount outlet boxes shall be installed as follows:
   a. Install surface mounted outlet boxes so that the back of the box is flush with the final finished surface of the surrounding wall finish.
   b. Install surface boxes plumb and true. Coordinate box size with device size. Any surface mount back box which allows the receptacle-outlet cover plate to overhang the edge of the box presents a safety hazard and shall not be acceptable.
7. Surface treatments with Architect prior to installation
8. Mark the inside of all back boxes with the device designation as indicated in the theatrical systems drawings using a permanent marker or paint pen.

E. Wiring Device Installation
1. All theatrical systems devices are to be mounted as shown on the drawings. Deviations from mounting methods shown on the drawings due to field conditions should be approved by the Architect prior to installation.
2. Mark the inside of all back boxes with the device designation as indicated in the theatrical systems drawings using a permanent marker or paint pen.
3. All network device cover plates must be labeled with the allowable remaining portable cable length such that the entire run does not exceed 300 feet or individual system specification, whichever is less.
4. Clean all boxes of any dust, dirt or debris prior to cover plate installation.
5. All devices, plates & equipment must be covered after installation and protected from construction dust and debris.

F. Theatrical Systems Control Cables
1. Theatrical Systems Ethernet network shall be Category 5e UTP /100Base-TX cabling installed in accordance with all applicable standards including but not limited to IEEE 802.3u standard.
   a. Cable runs between hubs shall not exceed 250 feet (75 meters). Contractor shall verify run lengths prior to installation.
   b. No splices. No exceptions.
   c. Contractor shall provide field installation reports verifying that cable installations comply with specifications.
2. Theatrical Systems Fiber Optic (single-mode fiber back bone) /100Base-FX cabling shall be installed in accordance with all applicable standards including but not limited to IEEE 802.3u standard (if required).

3. Termination of all control cabling shall be undertaken only under the direct supervision of the applicable Theatrical System Manufacturer’s authorized field service personnel.

3.2 SYSTEM STARTUP AND COMMISSIONING

A. Test, “ring out” and provide industry standard compliance documentation for all cable types provided for the theatrical systems and equipment, including but not limited to:
   1. 120V power receptacles
   2. Category cable & network devices
   3. Fiber optic devices

B. Provide personnel at the time of commissioning to supervise the inspection / testing of theatre systems related electrical equipment. This includes distribution boards, circuit breaker panels, relay panels, and all mains voltage devices installed under this section.

C. Provide the appropriate test equipment for the commissioning of theatre systems related electrical equipment.

D. Provide access (ladders, lifts, scaffolding, etc.) to all theatre systems related electrical equipment for inspection at the time of commissioning.

3.3 FIELD QUALITY CONTROL

A. Field Tests and Inspection:

1. Electrical Contractor shall replace any Theatrical Systems cable that was damaged during cable pull within empty conduit infrastructure.

2. Prior to energizing of the Theatrical Systems, perform complete system check-out to verify that all items are correctly installed and shall safely operate as specified herein.

3. Perform required tests and adjustments upon completion of installation of Theatrical Systems, including but not limited to those specified herein.

4. Contractor shall provide sufficient field service personnel (minimum of 2) to perform all tests specified below. Contractor shall furnish sufficient workmen to operate all equipment and to assist in all tests specified below. Contractor shall provide ladders and other devices, to allow access to all devices to be tested and communication between parties.

5. Contractor shall carry out the following inspections of the Theatrical Systems cabling and submit to the Theatre Consultant the written results at each inspection for inclusion on the permanent records of the theatrical systems. Follow EIA standards RS-160 and RS-219 in performing test. Make corrections necessary to bring system(s) into compliance with the specifications.

a. Category Cable:

1) Test cabling using at least one (1) of the following test measurement devices or equal:

a) Category 5e/6 Cable Pair Tester, Level III or later tester for full compliance with TIA/EIA 568-B.1 and B.2, (to include all current addendums) - Microtest Omniscanner, HP, Scope, Fluke, Siemon, or equal.

b) Outside Plant Voice Cabling Plant tester - capable of detecting shorts, opens, reversals, mis-wiring and crosstwists. (example: Siemon STM-8).

2) Performance Requirements
Theatrical System Electrical Requirements

a) To EIA/TIA standards referenced herein for Category 5e/6 cabling. Performance requirement is for circuit end-to-end.

3) Test Procedures:
   a) Use the specified Category cable test set, and test using the Permanent Link procedure.
   b) Verify that all Category cable runs meet TIA/EIA-568B compliance, using an appropriate Level III testing instrument. The instrument must verify the integrity of all conductors, as well as correctness of termination sequence. Tests shall be performed between modular jacks at TA panels and modular jacks at patch panel.
   c) Test station wire only after all pairs of station wire in an area have been terminated at both ends, and no work of this Section or other Sections may cause physical disturbance to the wiring.
   d) Test and submit a test report for each individual cable segment.
   e) Provide 250MHz sweep test, polarity checks, near-end cross talk, signal attenuation, noise, DC loop back resistance, pair-by-pair continuity and length.
   f) Submit a test report indicating that the link meets Category 5e/6 minimum requirements for at least the following parameters.
      • Wire map, pin to pin match
      • Length
      • Report by frequency:
      • Insertion loss
      • NEXT, worst pair to pair
      • Power sum NEXT
      • ELFEXT, worst pair to pair
      • Power sum ELFEXT
      • Return loss
      • Report pass or fail
   g) Correct any and all transpositions found
   h) Retest
   i) If any conductor in a station wire tests either open or short, then the entire station wire is to be removed, replaced, and re-tested.

b. Fiber Optic Cable:
   1) Test cabling using at least one (1) of the following test measurement devices or equal:
      a) Optical power meter (HP, Siecor, 3M, Fotec).
      b) Optical Time Domain Reflectometer (Tektronix TTP2 Fiber Master Optical Time Domain Reflectometer or equal).
   2) Performance Requirements
      a) Optical Budget, any end to end link - not to exceed the sum of the following:
         • The specified cable performance, pro-rated for total link distance.
         • Multimode:
            • 1). 0.03 dB for each fusion splice
            • 2). 0.3 dB for each mechanical splice
            • 3). 0.4 dB for each LC connector
   3) Test Procedures:
      a) Measure and record all fiber optic line End-to-End attenuations in accordance with TIA/EIA-526-14A using factory terminated test jumpers. Overall line attenuation, including all patch panel connections and mechanical or fusion splices shall be in accordance with TIA/EIA-
568B. All fiber connectors shall be tested to assure insertion losses < 0.3 dB (typical) and 0.75 dB (maximum).

b) Test each fiber link for overall attenuation from end to end in both directions.

c) Perform the attenuation acceptance test for multi-mode cable at both the 850nm and 1300nm wavelengths.

END OF SECTION 26 55 61
SECTION 26 56 00
EXTERIOR LUMINAires

PART 1 - GENERAL

1.1 SUMMARY

A. The work in this section includes furnishing and installing the following major elements, components, and associated accessories:

1. Exterior (Wet and Damp Label) luminaires and accessories
2. Fixture finishes
3. Light sources, lamps
4. Lampholders
5. Ballasts, transformers and drivers
6. Luminaire Accessories
7. Poles

B. Related sections

1. Introductory Information, Bidding Requirements, Contracting Requirements.
2. Division 01 – General Requirements
3. Division 09 – Finishes
4. Division 10 - Specialties
5. Division 26 – Electrical
6. Division 27 – Communications
7. Division 28 – Electronic Safety and Security

1.2 REFERENCES

A. Refer to Division 01 for general project references and standards.

B. All sections under Divisions of the American National Standards Institute (ANSI) related to electrical devices for lighting

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESA) Standard 90.1

D. Electrical Testing Laboratories, Inc. (ETL)

E. Illuminating Engineering Society of North America (IESNA)

F. International Energy Conservation Code (IECC)

G. National Electrical Code (NEC)

H. National Electrical Contractors Association (NECA)

I. National Electrical Manufacturers Association (NEMA)
J. National Fire Protection Association (NFPA) 70 National Electrical Code
K. Underwriters Laboratories, Inc. (UL)

1.3 SYSTEM DESCRIPTION

A. Performance Requirements

1. Contractor shall provide and install all components necessary for a complete working luminaire or luminaire system.

1.4 SUBMITTALS

A. Refer to Division 01 – Submittals for project submittal procedures.

B. Provide the required number of submittals promptly and deliver through appropriate channels, leaving sufficient time for adequate review and possible re-submittals without jeopardizing project schedule.

1. Allow a minimum of ten (10) working days for the Lighting Consultant to review a submittal or re-submittal.

C. Contractor is responsible for verification of all actual field dimensions, quantities, coordination, and compliance with contract documents.

D. No release of orders for lighting equipment shall be made until review of submittals is complete.

E. Contractor-originated submittals: The submittals should demonstrate that the Contractor has coordinated the details of the equipment with the manufacturer including the mounting requirements, the architectural conditions, and the electrical requirements, as well as verified any recent changes in equipment availability.

1. Copies of the Lighting Designer’s or Architect’s construction documents cut sheets are not acceptable. The Contractor and/or the Contractor’s supplier shall provide their own submittal information for review.

F. Submit an indexed list of fixture types and quantities and catalog cuts for all product data. Manufacturer’s product data shall be marked clearly to indicate all technical information that indicates conformance to all specified requirements in contract documents. Product data shall include, but not be limited to, the following information:

1. Manufacturer’s catalog sheets of standard fixtures, indicating materials, gauges, dimensions, standard finishes available, weights, label by Underwriters’ Laboratories Inc. (UL) or an equivalent organization acceptable to the jurisdictional authority.
2. Notation of any variation from the specified product. This includes manufacturer initiated revisions or replacements of the specified product.
3. Photometry: Candlepower curves and/or other photometric performance data from the manufacturer’s catalogue sheets or printout of the IES file.
4. Manufacturer’s catalog sheets of lamps to be provided with fixtures indexed to fixture types.
5. Complete LED driver/power supply information as applicable to each fixture type. Submittal is to include the transformer or driver/power supply manufacturer name, part number and electrical specifications, including operating frequencies. LED driver/power
supply information shall also include corresponding compatible dimming devices, if dimming is required.

6. For lighting fixtures or components with cooling fans, or other potential sources of noise, submittal information shall include measured noise output in decibels (dB).

7. Manufacturer’s catalogue sheets for all specified accessories.

8. An inventory of all other equipment to be supplied including types, quantities, and reference to applicable drawings and schematics.

9. The equipment manufacturer shall provide additional information or demonstrations as required by the Owner or Architect to show conformance with Part 2 of this Specification. The additional information or demonstrations shall only be required prior to submittal final approval and by written notification from the Architect, or should product delivered to the job site be different from materials described in final submittals or published product literature. All demonstrations shall at a location and time and in a manner chosen by the Owner.

G. Submittals shall be reviewed according to scope of work.

1. The Lighting Consultant shall review only the fixture types within their scope of work. Those types are designated in the fixture schedule and on the drawings with the prefix “L”.

2. Provide fixture submittals/shop drawings for all fixtures in the scope of work concurrently as one complete package. Return submittals shall in one complete package containing only the fixtures still needing review.

3. Incomplete or partial submittals/shop drawings shall be returned without review.

H. Shop Drawings

1. Provide shop drawings for nonstandard fixture types and configurations.

2. Shop drawing submittals shall include:

   a. One paper copy of the complete, fully dimensioned fixture drawings including all major components and details of fabrication.

   b. An electronic copy of the shop drawings in PDF scalable and printable format.

   c. Related architectural schematics with plans, sections and details indicating assembly, structural coordination, and installation of components.

   d. Inventory of all equipment to be supplied including types, quantities and reference to applicable drawings and schematics.

   e. Approximate weight of fully assembled fixture configurations.

   f. A complete finish schedule indicating the finish of all visible parts.

I. Light Fixture Mock-Ups

1. Upon approval of the shop drawing submittals, provide mock-ups of the fixture types to be determined, for aesthetic and functional approval by the Architect.

J. Manufacturer’s Instructions

1. Provide manufacturer’s instructions for proper storage, handling, protection, examination, preparation, and installation of product to the Contractor prior to installation.
K. Closeout Submittals
   1. Coordinate with Division 01 – Execution Requirements.

L. Operation and Maintenance Data
   1. Coordinate with Division 01 – Facility Operation.

M. Substitutions
   1. The identification and submittal of fixtures proposed as substitutions shall be in accordance with Part 2 of this specification section, and Division 01 – Product Requirements, and Bidding and Contracting Requirements.
   2. The Owner / Architect is final authority concerning whether a proposed substitution is acceptable.
   3. Submittals for fixtures proposed as substitutions shall meet the submittal requirements listed above, and the additional submittal requirements listed below:
      a. The deadline for submittals for proposed substitutions shall be the earliest date determined by either:
         1) The deadline established in Division 01 of this specification.
         2) A date early enough to meet construction schedule requirements including time for substitutions submittal reviews. The minimum time allowance for substitutions submittal reviews shall be the time allotted for reviews of named fixture submittals plus an additional ten (10) working days.
      b. All proposed substitutions shall be included in a single submittal package.
      c. Any fixture that differs in any manner from that scheduled by manufacturer's name shall be marked "exception", and exact differences shall be clearly indicated.
      d. Associated unit cost credits to the owner for the proposed substitution shall be identified.
      e. Photometry from an independent testing laboratory calculated according to IESNA standards is required.
         1) Photometry shall include at a minimum:
            a) Candlepower distribution curve and table printed on paper. Data in table shall have vertical angles no greater than 10° increments, (5°, 15°, and 25° etc.). All asymmetric distributions shall have quadrants represented in 22.5° increments, (parallel, 22.5°, 45° ... normal), or sufficient increments to fully describe asymmetric light distribution.
      f. Samples shall be required for all nonscheduled manufacturers that are submitted with insufficient data. Samples shall be provided for any proposed substitution upon request of the Architect.
      g. Calculations of light levels produced by the substituted fixtures shall be required. Calculations shall:
1) Be performed using a recognized industry standard computerized lighting program. Acceptable software for computerized lighting programs includes, but is not limited to AGI by Lighting Analysts, Inc.

2) Be presented as a point-by-point grid of maintained footcandle levels taken at the horizontal plane at grade. The grid shall overlaid graphically on a to-scale light fixture layout with clearly identified fixture types.

3) Include the total Light Loss Factor used and a list of the individual loss factors in its composition.

4) Include an indexed list of the electronic photometry files used to represent the light fixtures.

5) Include an indexed list of the light fixture heights used in the calculation.

6) Include an indexed list of the lamp lumens and fixture wattages used in the calculation.

4. All additional expenses of any kind with respect to substitution(s) shall be born by the Contractor/Bidder. This shall include, but not be limited to, all fees and expenses incurred by the Architect and other related Consultants for evaluation of the substitution and subsequent integration into the project, should the substitution be taken; and/or additional costs of other contractors related to the substitution(s).

1.5 QUALITY ASSURANCE

A. Manufacturers qualifications

1. The manufacturer shall own and operate his/her own shop for fabrication of architectural luminaires and be regularly engaged in the fabrication and installation of such equipment. Fabrication of such equipment shall comprise no less than 90% of the manufacturer's business.

2. The Manufacturer shall have been engaged in the fabrication of the above equipment for at least the past 5 years

B. Regulatory Requirements

1. All luminaires shall be included in a list published by a National Recognized Testing Laboratory acceptable to the authority having jurisdiction and concerned with product evaluation such as Underwriters Laboratory (UL) or ETL.

1.6 DELIVERY, STORAGE & HANDLING

A. Delivery, storage and handling shall be coordinated with the General Contractor and shall meet all requirements described in Division 01 – Product Requirements.

B. Packing, Shipping, Handling & Unloading

1. Equipment shall be individually wrapped and sealed and substantially crated for shipment. All handling and shipping shall be performed in accordance with manufacturer's recommendations. Store products in unopened cartons in a protected location.
2. All shipping costs to the job site are the responsibility of the Contractor. The shipping method/company is at the discretion of the Contractor in order to facilitate Acceptance at Site.

C. Acceptance at Site

1. The Contractor shall be responsible for acceptance of lighting equipment at the jobsite, confirming that all quantities and counts are correct and for keeping accurate logs and records of such information. Logs and records shall include but not be limited to date of shipment, date of acceptance at the jobsite, name and signature of individual accepting equipment at the jobsite, location of storage area, and confirmation of quantity counts listed on bills of lading. A copy of the shipping invoice or bill of lading shall be kept with each log entry of acceptance at the jobsite. Logs and records shall be made available to the Owner immediately upon request.

D. Storage and Protection

1. Upon delivery, the materials shall be stored under cover in a dry and clean location, off the ground. Delivered materials which are damaged or otherwise not suitable for installation shall be removed from the job site and replaced with acceptable materials.
2. Replace at no expense to the Owner, all equipment and materials which are damaged during storage or handling.
3. Delivery of material shall be scheduled to reduce on-site storage time required.
4. Refer to Division 01 for additional storage and protection requirements.

1.7 PROJECT / SITE CONDITIONS

A. Environmental Requirements

1. Verify all conditions at jobsite. Promptly report variations and obstructions to the Owner. All additions and or corrections shall requested prior to fabrication.

B. Existing Conditions

1. Verify all conditions at jobsite.
2. Confirm adequate support and footings for pole mounted fixtures.

C. Field Measurements

1. Where possible, field measurements shall be taken prior to installation preparations.

1.8 SEQUENCING AND SCHEDULING

A. The Contractor shall provide a schedule of milestone completion dates for specific areas required to be completed prior to installation of equipment provided under this section to the General Contractor. These completion dates shall describe the required condition and level of finish required of each space.

1. The installation of the lighting equipment shall not occur until all painting in the area has been completed.
2. The installation of any lighting components sensitive to construction debris and dust shall not be installed until all debris and dust has been removed.
1.9 WARRANTY

A. Refer to Division 01 – Execution Requirements.

B. Contractor shall provide his/her own warranties as well as factory warranties. All equipment and labor in this contract shall be free from defects in products or workmanship for at least one year after date of acceptance of installation by Owner, unless otherwise noted or approved by Owner.

1.10 SYSTEM STARTUP, OWNER’S INSTRUCTIONS & COMMISSIONING

A. Coordinate with Division 01 – Execution Requirements and Facility Operation.

B. Instruction shall be provided to the Owner for proper relamping or replacing LED module procedures for all luminaires.

1.11 MAINTENANCE

A. Extra Materials

1. Coordinate with Division 01 – Execution Requirements.

B. Maintenance Service

1. Lighting system maintenance shall be in accordance with Division 01 – Facility Operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. For the purpose of establishing minimum functional and aesthetic criteria, product manufacturers have been indicated in the Exterior Light Fixture Schedule attached to the end of this Section.

B. Substitutions shall be in compliance with Division 1 – Product Requirements.

C. Fixture groups by the same manufacturer

1. All products of the same specified type shall be by the same manufacturer

2.2 MANUFACTURED UNITS

A. Fixture types are indicated by alphanumeric designations.

B. Provide all products with UL Label for the appropriate mounting conditions or with equivalent label by another National Recognized Testing Laboratory acceptable to the authority having jurisdiction.

C. Voltage is as specified in the Exterior Lighting Fixture Schedule. Lamps shall be operated at no greater than their rated voltage.
D. In all cases where a device or a part of the equipment is referred to in a singular manner in the contract documents, it is intended that such reference shall include and apply to as many devices as are required to complete the installation.

E. Provide lighting fixtures new and complete with mounting accessories, junction boxes, trims and lamps.
   1. Provide lamps indicated on the Exterior Lighting Fixture Schedule, or if not indicated, as recommended by the fixture manufacturer. Lamps shall be compatible with the respective fixture in all cases.
   2. Fixture Type catalogue numbers do not necessarily denote required mounting equipment or accessories. Provide all appropriate mounting accessories for all mounting conditions.

F. All recessed fixtures shall have the appropriate NEMA-Type frame that is compatible with the ceiling type specified by the Architect.

G. Fixtures in non-accessible ceilings shall have accessible junction boxes, ballasts, and transformers through fixture apertures.

H. All fixtures shall be free of inappropriate light leaks.

I. No metal clips, screws, angles, etc. shall be visible when the fixture is viewed from below.

J. Die casts shall be smooth, free of pits, grooves, and imperfections.

K. Spinnings shall be smooth and clean with finished edges, and free of spinning lines.

L. Fixtures shall be ventilated for proper ballast, driver and light source operation.

M. Recessed fixtures shall have integral thermal protection.

N. All adjustable fixtures shall have locking rotation and tilt devices.

2.3 COMPONENTS

A. Light Sources
   1. LIGHT EMITTING DIODE (LED)
      a. LED sources shall be integrated in luminaire with Correlated Color Temperature (CCT) 3000K and Color Rendering Index (CRI) exceeds 80.
      b. The LED shall emit no UV or IR.
      c. The LED shall deliver average lumen maintenance of 70% through 50,000 hours minimum under typical conditions. Proper current de-rating shall be observed to maintain junction temperature below the rated maximum.
      d. LED modules in the same L series fixture type shall have consistent color. Excessive color variation observed by Architect shall be replaced by the Contractor at no additional expense to the Owner.

B. Lampholders
1. Lampholders shall hold lamps securely to prevent damage caused by normal vibrations and maintenance handling.

C. Reflector Cones

1. Cone flange shall be formed as an integral part of cone and shall have identical appearance as inner cone unless otherwise indicated. Flange overlap shall have a perpendicular orientation to cone and shall have adequate width to cove ceiling opening with no visible light leaks.

D. Light Emitting Diode (LED) drivers

1. LED power supplies and dimming devices shall have short circuit, overload, and overheating protection.
2. LED power supplies, LED dimming devices, and LEDs or fixture-integrated LEDs shall each be compatible with the other LED devices to which they are connected. Inter-compatibility of LED devices shall be as determined by the manufacturers of those devices.
3. LED power supply and LED dimming devices provided shall be compatible with specified lighting controls.
4. Power supply output and secondary load wiring size shall be adjusted to accommodate for voltage drop over the entire length of the run.
5. Dimming range shall be 10–100% unless otherwise indicated in the Light Fixture Schedule.
6. Light level output shall be continuous, even, and flicker-free over the entire dimming range.

E. Housings

1. Provide safety devices for removable fixture elements, (cones, louvers, lenses, etc.). Safety device shall support element while out of normal operating position and be removable. Safety device shall not interfere with normal operation of fixture.

F. Louvers, baffles, diffusers, lenses

1. Fixtures with baffles/louvers riveted or welded to the housing are not acceptable.

G. Poles

2. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

2.4 ACCESSORIES

A. Provide all individual fixtures with accessories as listed in the Exterior Light Fixture Schedule.

2.5 FIXTURE FINISHES

A. Fixture finishes shall be coordinated with the General Contractor and shall meet all requirements described in Division 09 – Paints and Coatings.

B. All color finishes shall approved by the Architect.

C. Painted finish
1. All painted finish shall be factory applied.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine each luminaire to determine suitability for lamps specified.

B. The Contractor shall verify the site conditions for suitability of installation. If errors or defects exist in luminaire mounting locations, the luminaires shall be withheld from installation until the situation is remedied.

C. Self-flange cones shall be factory painted, not field painted, unless otherwise noted in Interior Lighting Fixture Schedule.

D. All custom color finishes shall approved by Architect.

3.2 INSTALLATION

A. Light fixture installation shall be coordinated with the General Contractor and shall meet all requirements described in Division 01 – Execution Requirements.

B. Light fixtures shall be installed as located on architectural plans and as zoned for control per electrical drawings and per approved shop drawings.

C. Light fixtures shall be installed in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, applicable NECA Recommended Practices, NEMA standards, and recognized industry practices.

D. Verify locations and spacing of lighting fixtures with drawings and notify Architect of any variance or conflict between the plans and field conditions. Do not proceed until conflict has been resolved.

E. Work shall be coordinated with other trades.

F. Structural support of all fixtures shall comply with the applicable building codes having jurisdiction over the project.

G. Provide all necessary hardware and blocking to ensure that fixtures are mounted level, true, square, plumb, and in proper alignment.

H. All fixtures shall be unpacked, lamped, accessorized and installed for the final adjustment by the Contractor under the direction of the Architect.

I. Luminaires shall be bonded to branch circuit equipment-grounding conductor.

3.3 FIELD QUALITY CONTROL

A. Coordinate with Division 01 – Quality Requirements.
B. Operate each luminaire after installation and connection. Inspect each fixture for proper connections and operation.

C. Perform testing of operation of temporary or emergency power systems.

D. Verify that all lenses, louvers, baffles, fixture trim cones, diffusers and other parts are thoroughly cleaned in a manner recommended by the manufacturer.

E. Replacement of blemished parts: Any luminaire components, including but not limited to reflector cones and louvers, that have been over-sprayed or damaged by paint or other materials bonding permanently to surfaces shall be replaced at no cost to the Owner.

3.4 ADJUSTING

A. Coordinate with Division 01 – Execution Requirements.

B. All adjustable architectural luminaires shall be focused, aimed or otherwise adjusted by the Contractor under the direction of the Architect during the final adjustment.

1. Lighting adjustment shall take place after the project’s amenities, such as furniture, artwork, graphics, signage, planting and final finishes, have been installed and after any system commissioning has happened.

2. The Contractor shall provide personnel to work with the Architect’s personnel to adjust the lighting fixtures. The Architect shall direct representative examples of fixture adjustment for the Contractor, but shall not adjust each individual fixture. The Contractor shall be responsible for adjusting all fixtures.

   a. The Contractor shall provide personnel as required to aim and adjust the light fixtures.

   b. Contractor’s personnel shall be familiar with the installed lighting equipment and the lighting controls for the site.

   c. Lighting fixture adjustments shall occur at night.

   d. The focusing and checkout of the lighting requires that all work lights be turned off in the area of the lighting adjustments.

3. The Contractor shall provide tools and any special equipment needed for the adjustments including walkie-talkies for communication.

4. The Contractor shall provide lifts and/or ladders at heights required to reach all light fixtures.

3.5 CLEANING

A. Coordinate with Division 01 – Execution Requirements.

3.6 DEMONSTRATION

A. Coordinate with Division 01 – Facility Operation.
B. Maintenance personnel shall be advised on replacing the light source, re-lamping and maintenance procedures and be given by the Contractor a list of light sources required for the light fixtures on the project.

3.7 PROTECTION

A. Lighting fixtures, once installed, shall be protected from damage during the remainder of construction period.

3.8 SCHEDULE

A. For additional information, refer to the Exterior Light Fixture Schedule in the Electrical drawings and Product Data Sheets (catalog cuts) following the end of this Section.

END OF SECTION 26 56 00
SECTION 265613
LIGHTING POLES AND STANDARDS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Poles and accessories for support of luminaires.

1.3 DEFINITIONS
A. EPA: Equivalent projected area.
B. Luminaire: Complete lighting fixture.
C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.
D. Standard: See "Pole."

1.4 ACTION SUBMITTALS
A. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device, arranged as indicated.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers' catalog sheets with complete technical data for each item being furnished.
   7. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
   8. Include finishes for lighting poles and luminaire-supporting devices.
   10. Manufactured pole foundations.

1.5 INFORMATIONAL SUBMITTALS
A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.
B. Material Test Reports:
   1. For each foundation component, by a qualified testing agency.
   2. For each pole, by a qualified testing agency.
C. Source quality-control reports.
D. Field quality-control reports.
E. Sample Warranty: Manufacturer's standard warranty.
F. Soil test reports.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For poles to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017800 "Closeout Submittals," include pole inspection and repair procedures.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Pole repair materials.

1.8 QUALITY ASSURANCE
A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for foundation testing.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Package aluminum poles for shipping according to ASTM B 660.
B. Store poles on decay-resistant skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
C. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.10 WARRANTY
A. Special Warranty: Manufacturer agrees to repair or replace components of pole(s) that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.
   2. Warranty Period for Corrosion Resistance: Five years from date of Substantial Completion.
   3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014500 "Quality Control," to design pole foundation and pole power system.
B. Structural Characteristics: Comply with AASHTO LTS-6-M.
C. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.
D. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.
E. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.
1. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 100 mph (45 m/s)
   a. Wind Importance Factor: 1.0
   b. Minimum Design Life: 25 years
   c. Velocity Conversion Factor: 1.0

F. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.

G. Luminaire Attachment Provisions: Comply with luminaire manufacturers’ mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.2 STEEL POLES

A. Source Limitations: Obtain poles from single manufacturer or producer.

B. Source Limitations: For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties.

C. Poles: Comply with ASTM A 240/A 222, stainless steel with a minimum yield of 55,000 psig (379 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
   1. Shape: Square, straight.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

D. Brackets for Luminaires: Detachable, cantilever, without underbrace.
   1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adapter, then bolted together with galvanized-steel bolts.
   2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.

E. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

F. Fasteners: Galvanized steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
   1. Materials: Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.

G. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 “Grounding and Bonding for Electrical Systems,” listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.

H. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

I. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported load multiplied by a 5.0 safety factor.

J. Prime-Coat Finish: Manufacturer’s standard prime-coat finish ready for field painting.

K. Galvanized Finish: After fabrication, hot-dip galvanize according to ASTM A 123/A 123M.

L. Powder-Coat Finish: Comply with NAAMM’s “Metal Finishes Manual for Architectural and Metal Products” recommendations for applying and designating finishes.
1. **Surface Preparation:** Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. **Powder Coat:** Comply with AAMA 2604.
   a. Electrostatic-applied powder coating; single application and cured to a minimum 2.5- to 3.5-mils dry film thickness. Coat interior and exterior of pole for equal corrosion protection.

### 2.3 ALUMINUM POLES

**A. Poles:** Seamless, extruded structural tube complying with ASTM B 221, Alloy 6063-T6, with access handhole in pole wall.

**B. Brackets for Luminaires:** Detachable, cantilever, without underbrace.
   1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adapter, then bolted together with stainless-steel bolts.
   2. **Cross Section:** Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.

**C. Pole-Top Tenons:** Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

**D. Grounding and Bonding Lugs:** Bolted 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 “Grounding and Bonding for Electrical Systems,” listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

**E. Fasteners:** Stainless steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
   1. **Materials:** Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.

**F. Handhole:** Oval shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

**G. Prime-Coat Finish:** Manufacturer's standard prime-coat finish ready for field painting.

**H. Powder-Coat Finish:** Comply with NAAMM’s "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
   1. **Surface Preparation:** Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
   2. **Powder coat shall comply with AAMA 2604.**
      a. Electrostatic applied powder coating; single application with a minimum 2.5- to 3.5-mils dry film thickness; cured according to manufacturer's instructions. Coat interior and exterior of pole for equal corrosion protection.

### 2.4 MOUNTING HARDWARE

**A. Anchor Bolts:** Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi (380,000 kPa).
   1. **Galvanizing:** Hot dip galvanized according to ASTM A 153, Class C
   2. **Threading:** Uniform National Coarse, Class 2A.

**B. Nuts:** ASTM A 563, Grade A, Heavy-Hex
1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C
2. Two nuts provided per anchor bolt.

C. Washers: ASTM F 436, Type 1.
   1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C. Two washers provided per anchor bolt.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C. Examine roughing-in for foundation and conduit to verify actual locations of installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POLE FOUNDATION

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Anchor Bolts: Install plumb using manufacturer-supplied plywood template, uniformly spaced.

3.3 POLE INSTALLATION

A. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.
   1. Fire Hydrants and Water Piping: 60 inches (1520 mm)
   2. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet (3 m)
   3. Trees: 15 feet (5 m) from tree trunk.

B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch (25 mm) below top of concrete slab.
D. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.5 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
   1. Inspect poles for nicks, mars, dents, scratches, and other damage.
   2. System function tests.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices.

3.9 CLEANING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

3.10 EXTERIOR LUMINAIRE SCHEDULE

A. See drawings for Luminaire Schedule.

END OF SECTION
SECTION 265619
LED EXTERIOR LIGHTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Luminaire types.
3. Finishes.
4. Luminaire support components.

B. Related Requirements:
1. Section 260923 “Lighting Control Devices” for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 265613 “Lighting Poles and Standards” for poles and standards used to support exterior lighting equipment.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color rendering index.
C. Fixture: See “Luminaire.”
D. IP: International Protection or Ingress Protection Rating.
E. Lumen: Measured output of lamp and luminaire, or both.
F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers’ catalog sheets with complete technical data for each item being furnished.
   7. Arrange in order of luminaire designation.
   8. Include data on features, accessories, and finishes.
   9. Include physical description and dimensions of luminaire.
   10. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
   a. Manufacturer's Certified Data: Photometric data certified by manufacturer’s laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
   b. Provide certification of one of the following:
      1) LM-79-08 report at T=0 and at T=6000 hours with a summary table showing the percent lumen output change and percent input power change.
      2) LM-80-08 test data for the LEDs at the three temperatures per LM-80-08. Provide extrapolation data using an exponential decay function to show the output at 50,000 hours. Provide the Ts value from the LM-79-08 and where the point falls in relation to the LM-80-08 extrapolated data. Interpolate between the LM-80-08 data for the Ts temperature.

12. Wiring diagrams for power, control, and signal wiring.
13. Photoelectric relays.
14. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing laboratory providing photometric data for luminaires.
B. Product Certificates: For each type of the following:
   1. Luminaire.
   2. Photoelectric relay.
C. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
D. Source quality-control reports.
E. Sample warranty.

1.6 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers’ codes.
   2. Provide a list of all photoelectric relay types used on Project; use manufacturers’ codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. LEDs: Provide One for every 100 factory assembled replacement LED package with electrical leads. Furnish at least one of each type. May be unitized with power supply unit/driver.
   2. Power Supply Units/ driver: One for every 100 of each type and rating installed. Furnish at least one of each type. May be unitized with LEDs.
   3. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
   4. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
   5. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
   6. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
1.8 QUALITY ASSURANCE
A. Luminaire Photometric Data Testing Laboratory Qualifications:
   1. Luminaire manufacturers’ laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
B. Provide luminaires from a single manufacturer for each luminaire type.
C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS
A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY
A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures, including luminaire support components.
      b. Faulty operation of luminaires and accessories.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   2. Warranty Period: Two year(s) from date of Substantial Completion.
   3. Warranty Period for Light Sources: Five year replacement material warranty on all light sources (LED package, LED array, or LED module) including, but not limited to the LED die, encapsulate, and phosphor for the LEDs lumen maintenance not achieving L70 after 50,000 hours.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Products: Subject to compliance with requirements, [provide product indicated on Drawings] [provide one of the products indicated on Drawings] [available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings].

2.2 LUMINAIRE REQUIREMENTS
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. Lamp base complying with ANSI C81.61.

F. Bulb shape complying with ANSI C79.1.

G. Lamps dimmable from 100 percent to 0 percent of maximum light output.

H. Internal driver.

I. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

J. Source Limitations:
   1. Obtain luminaires from single source from a single manufacturer.
   2. For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 LEDS

A. LED sources must meet the following requirements:
   1. Operating temperature rating must be between -40°C and +50°C
   2. Correlated Color Temperature (CCT):
      a. Nominal CCT: 2700 K (2725 ± 145)
      b. Nominal CCT: 3000 K (3045 ± 175)
      c. Nominal CCT: 3500 K (3465 ± 245)
      d. Nominal CCT: 4000 K (3985 ± 275)
      e. Nominal CCT: 4500 K (4503 ± 243)
      f. Nominal CCT: 5000 K (5028 ± 283)
      g. Nominal CCT: 5700 K (5665 ± 355)
      h. Nominal CCT: 6500 K (6530 ± 510)
      i. Du’v’ tolerance of 0.001 ± 0.006
   3. Color Rendering Index (CRI): greater than or equal to 80.
   4. Luminaire manufacturer must submit reliability reports indicating that the manufacturer of the LED (chip, diode, or package) has performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows:
      a. High Temperature Operating Life (HTOL)
      b. Room Temperature Operating Life (RTOL)
      c. Low Temperature Operating Life (LTOL)
      d. Powered Temperature Cycle (PTMCL)
      e. Non-Operating Thermal Shock (TMSK)
      f. Mechanical Shock
      g. Variable Vibration Frequency
      h. Solder Heat Resistance (SHR)

2.4 LED DRIVERS / POWER SUPPLYS

A. LED drivers must meet the following requirements:
   1. Drivers must have a minimum efficiency of 85%.
   2. Starting Temperature: -40°C.
   3. Electrical Characteristics.
      a. Volts: as indicated on Luminaire Schedule.
      b. Phase: Single.
      c. Hertz: 60.
   4. Power supplies can be UL Class I or II output.
   5. Drivers must have a Power Factor (PF) of greater than or equal to 0.90.
6. Drivers must have a Total Harmonic Distortion (THD) of less than or equal to 20%.
8. Drivers must be Reduction of Hazardous Substances (RoHS) compliant.
9. Inrush current <2A
10. Sound rating: Inaudible in a 24 dB ambient.
11. Class P thermally protected.
12. Relative humidity: maximum 90% non-condensing.
13. Drivers with 0-10V dimming capability must be isolated and not allow current to leak between the power source and the 0-10V control circuit.

2.5 LED LUMINAIRES
A. Provide luminaires with integral LED thermal management system (heat sinking).
B. Luminaires shall be equipped with an LED driver that accepts 120V through 277V, 50hz to 60hz (UNIV). Component-to-component wiring within the luminaire will carry no more than 80% of rated current and be listed by UL for use at 600 VAC at 302°F/150°C or higher. Plug disconnects shall be listed by UL for use at 600 VAC, 15A or higher.
C. LED modules shall have a minimum L70 service life of 75,000 hours at 25°C ambient temperature and based on IESNA LM-80 methodology.
D. Provide luminaires with individual LED arrays/modules and drivers that are accessible and replaceable from exposed side of the luminaire. Luminaires requiring removal or replacement of entire luminaire to access LEDs and drivers will NOT be accepted.

2.6 MATERIALS
A. Metal Parts: Free of burrs and sharp corners and edges.
B. Sheet Metal Components: Epoxy-coated steel. Form and support to prevent warping and sagging.
C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
D. Diffusers and Globes:
   1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   2. Glass: Annealed crystal glass unless otherwise indicated.
   3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.
G. Housings:
   1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
   2. Provide filter/breather for enclosed luminaires.
H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp characteristics:
   a. "USE ONLY" and include specific lamp type.
   b. Lamp diameter, shape, size, wattage and coating.
   c. CCT and CRI for all luminaires.

2.7 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
   2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
   3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
   4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
      a. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] <Insert color>.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
   2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color:
         1) As selected from manufacturer's standard catalog of colors.
         2) Match Architect's sample of [manufacturer's standard] [custom] color.
         3) As selected by Architect from manufacturer's full range.

E. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
   2. Powder coat shall comply with AAMA 2604.
      a. Electrostatic applied powder coating; single application with a minimum 2.5- to 3.5-mils dry film thickness; cured according to manufacturer's instructions. Coat interior and exterior of pole for equal corrosion protection.
      b. Color:
         1) As selected from manufacturer's standard catalog of colors.
         2) Match Architect's sample of [manufacturer's standard] [custom] color.
         3) As selected by Architect from manufacturer's full range.
2.8 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, and canopy ceilings for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Fasten luminaire to structural support.

D. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Support luminaires without causing deflection of finished surface.
   4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:
   1. Attached to a minimum 1/8 inch (3 mm) backing plate attached to wall structural members.


G. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Coordinate layout and installation of luminaires with other construction.

H. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 INSTALLATION OF BOLLARD LUMINAIRE

A. Align units for optimum directional alignment of light distribution.
1. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.5 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.6 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
      
      a. If 0-10V dimming does not perform to expectations, the contractor shall provide low pass filters at the 0-10V source to remedy performance issues.
   
   2. Verify operation of photoelectric controls.

C. Illumination Tests:

   1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
      
      a. IES LM-5.
      b. IES LM-50.
      c. IES LM-52.
      d. IES LM-64.
      e. IES LM-72.
   
   2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
3.9 DEMONSTRATION
   A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires

3.10 CLEANING
   A. Clean units after installation. Use methods and materials recommended by manufacturer.

3.11 EXTERIOR LUMINAIRE SCHEDULE
   A. See drawings for Luminaire Schedule.

END OF SECTION
SECTION 26 99 98
AUDIO/VIDEO TECHNICAL POWER SYSTEMS

PART ONE - GENERAL

1.1 GENERAL REQUIREMENTS
A. Applicable requirements of the Contract Documents and general requirements of other Division 26 Sections apply to the work of this Section.
B. The Electrical Contractor shall refer to the large-format audio & video system drawings for the locations and quantities of all audio & video technical power system circuits, outlets, receptacles, and company switches.

1.2 INTENT
A. It is the intent of this section to inform the Electrical Contractor about specific requirements for the installation of the audio & video technical power system.
B. Certain items related to the audio & video technical power (AVTP) system may require equipment or installation techniques which differ from those normally called out in Division 26.

1.3 SCOPE OF WORK
A. The Electrical Contractor shall furnish and install the audio & video technical power system as outlined in this Section and Division 26.
B. The division of labor between the Electrical Contractor and the Audio & Video Contractor is detailed in the Work Scope Table in Section 27 41 00.

1.4 AUDIO & VIDEO TECHNICAL POWER SYSTEM DETAILS
A. One or more double shielded harmonic mitigating transformers (AVTP System Transformer(s)) are required between the audio & video system equipment and all other building services. All of the AVTP system circuits, outlets, receptacles, and company switches must be fed from the AVTP system transformer(s).
B. Only those circuits, outlets, receptacles, and company switches identified as AVTP may be connected to the AVTP system panels.
C. A totally isolated grounding system is required for all audio & video system equipment on the AVTP system. A separate, insulated ground path is required between all audio & video technical power system locations and the isolated ground source.

1.5 SUBMITTALS
A. A written verification report of the isolated ground system is required.

PART TWO - PRODUCTS

2.0 GENERAL
A. No substitutions are allowed for the specified equipment without the written authorization of the Electrical Engineer and the Audio & Video Designer.

2.1 HIGH HARMONIC LOAD ISOLATION TRANSFORMERS
A. Subject to compliance with requirements, provide UL rated Harmonic Mitigating Transformer with copper windings and double electrostatic shielding.
1. Manufacturer – Hammond Power Solutions
2. Model Series – HPS Centurion

2.2 DISTRIBUTION PANEL BOARDS
A. Subject to compliance with requirements, provide distribution panel board for non-linear loads with 200% rated neutral.
   1. Manufacturer – Square D.
   2. Model Series – I-LINE
B. Each panel board shall contain an isolated ground buss bar.
C. Each panel board shall have a label engraved “AUDIO & VIDEO ONLY - TECHNICAL POWER”.

2.3 COMPANY SWITCHES
A. Subject to compliance with requirements, provide company switch for portable audio & video equipment.
   1. Manufacturer – LEX Products
   2. Model Series – CS-xxxx-C6DS1
B. Each company switch shall contain an isolated ground buss bar.
C. Each company switch shall have a label engraved “AUDIO & VIDEO ONLY - TECHNICAL POWER”.

2.4 WIRING DEVICES
A. Outlets
   1. Subject to compliance with requirements, provide orange-colored isolated ground outlets.
      a. Manufacturer – Hubbell
      b. Model number – IG series as appropriate per power requirement
   2. Each outlet wall plate shall be engraved “AUDIO & VIDEO ONLY - TECHNICAL POWER”.
B. Power Strips
   1. Subject to compliance with requirements, provide power strips as needed.
      a. Manufacturer – LEGRAND-WIREMOLD
      b. Model Series – 20IGxxx
   2. Each power strip shall be engraved “AUDIO & VIDEO ONLY - TECHNICAL POWER”.
C. Auxiliary Receptacle Company Switch
   1. Subject to compliance with requirements, provide auxiliary receptacle company switches as needed.
      a. Manufacturer – LEX Products
      b. Model Series – CS-60F-D5PS1
   2. Each auxiliary receptacle enclosure shall be engraved “AUDIO & VIDEO ONLY - TECHNICAL POWER”.

PART THREE - EXECUTION

3.1 INSTALLATION - GENERAL
1. All of the audio & video technical power system circuits, outlets, receptacles, and company switches must be fed from the AVTP panels.
2. Only those circuits, outlets, receptacles, and company switches identified as AVTP may be connected to the audio & video technical power system panels.
3. A totally isolated grounding system must be maintained for the entire audio & video technical power system.
4. The AVTP system and isolated grounding system are detailed on electrical and audiovisual design drawings.

3.2 INSTALLATION - VOLTAGE

A. The AVTP Transformer(s) must be installed and adjusted so that the Voltage at the audio & video load center panels is 120 VAC +/- 3%.

3.3 INSTALLATION - GROUNDING

1. An isolated ground system is required for all audio & video system equipment. This ground system is in addition to any code requirements for safety ground. This system requires that:
   a. All auxiliary receptacles, load center panels, and company switches are connected, through separate insulated cables, to the isolated ground buss bar located in, or adjacent to, the distribution panel boards.
   b. All individual circuits and outlets are connected, through separate insulated cables, to the isolated ground buss bar located in, or adjacent to, the load center panels.
2. The AVTP system and isolated grounding system are detailed on electrical and audiovisual design drawings.

3.4 INSTALLATION - LOAD CENTER PANELS

1. The Electrical Contractor shall install the customized sequencing load center panels which are provided by the Audio & Video Contractor.

3.5 INSTALLATION - WIRING

1. Circuits and Outlets
   a. AVTP system circuits and outlets are called out on the large-format audio & video system drawings.
   b. Each of the circuits and outlets shall have an individual circuit breaker and may NOT be combined with additional outlets, except as indicated in the large-format audio & video system drawings.
   c. Each of the circuits and outlets shall have a separate, dedicated neutral conductor home run to the load center panel.
   d. Each of the circuits and outlets shall have a separate, insulated, isolated ground conductor home run to the load center panel.
   e. Wire sizes of branch circuit conductors shall be #10 AWG for hot and neutral conductors, and #8 AWG for isolated ground.
   f. All conductors terminating at duplex outlets require crimped spade lugs. Spade lugs shall be secured under the mounting screws. No push-in connections are allowed.
2. Auxiliary Receptacles
   a. Wire size of isolated grounding conductor must be #2 AWG or two wire gauges larger than the supply feeders, whichever is larger.
3. Panels
   a. Wire size of isolated grounding conductor must be #4/0 AWG or two wire gauges larger than the supply feeders, whichever is larger.
4. Equipment Racks
   a. Each audio & video equipment rack location requires a separate isolated ground conductor to the load center panel. The wire size of each conductor must be #2 AWG, minimum.

3.6 INSTALLATION - WIRING DEVICES

A. Circuits and Outlets
1. AVTP system circuits and outlets are called out on the audio & video system location drawings, and in the Power Schedule on the audio & video large format drawings.

2. Individual circuits called out as “deliver circuit to this location” shall be internally wired by the Audio & Video Contractor. They do not require wiring devices.

B. Power Strips

1. All of the outlets in each power strip are wired to one audio & video technical power system circuit. These power strips shall be mounted horizontally as shown on the audio & video system location drawings.

3.7 INSTALLATION - Conduit

A. All AVTP system conduit shall be bonded to the distribution panel boards, company switches, load center panels, receptacle backboxes, and outlet backboxes.

B. The AVTP system conduit shall NOT be connected to the isolated ground system.

C. All AVTP system circuits must run in conduits separate from all other circuits.

3.8 INSTALLATION - ISOLATED GROUND TEST

A. Refer to electrical and audiovisual drawings for details of the AVTP system and isolated grounding system.

1. Verify the integrity of the audio & video isolated ground system, as follows:
   a. Confirm that continuity is measured between each isolated ground receptacle/outlet neutral conductor and the grounding electrode at the AVTP system transformer(s).
   b. Disconnect the neutral bonding link at each AVTP system transformer and confirm that the neutral buss is isolated from the building ground. Locate and remove all connections between the neutral buss and the building ground other than the main bonding jumper. Reconnect the neutral bonding link.
   c. Confirm that continuity is measured between each isolated ground receptacle/outlet ground conductor and the grounding electrode at the AVTP system transformer(s).
   d. Disconnect the isolated ground bonding link at each AVTP system transformer and confirm that the isolated ground buss is isolated from the building ground. Locate and remove all connections between the isolated ground buss and the building ground other than the main bonding jumper. Reconnect the isolated ground bonding link.
   e. Confirm that each isolated ground receptacle/outlet is wired with correct polarity.

END OF SECTION
SECTION 26 99 99
AUDIO/VIDEO CABLE RACEWAY SYSTEMS

PART ONE - GENERAL

1.1 GENERAL REQUIREMENTS
1. Applicable requirements of the Contract Documents and general requirements of other Division 26 Sections apply to the work of this Section.
2. The Electrical Contractor shall refer to the large-format Audio/Video system drawings for the locations and quantities of all Audio/Video devices requiring cable raceway systems, and to the Performance AV Systems specifications, 27 41 00.

1.2 INTENT
1. It is the intent of this section to inform the Electrical Contractor about specific requirements for the installation of the Audio/Video cable raceway systems.
2. Certain items related to the Audio/Video cable raceway systems may require equipment or installation techniques which differ from those normally called out in Division 26.

1.3 SCOPE OF WORK
1. The Electrical Contractor shall furnish and install the Audio/Video cable raceway systems as outlined in this Section and Division 26.
2. The Electrical Contractor does not furnish or install the Audio/Video equipment or cabling. It is supplied by the Audio/Video Contractor.
3. The division of labor between the Electrical Contractor and the Audio/Video Contractor is detailed in the Work Scope Summary Table in Section 27 41 00.

1.4 AUDIO/VIDEO CABLE RACEWAY SYSTEM DETAILS
1. The Audio/Video cable raceway systems consist of the following:
a. The Metallic Conduit System is a network of empty conduits into which the Audio/Video Contractor shall install the cables for the Audio/Video system.
b. The PVC Conduit/Bevway Duct System is a group of empty conduits which are used to conceal temporary Audio/Video cables provided by road show productions.
c. The Cable Sleeve System allows temporary Audio/Video cables to pass through walls and floors.
d. The Cable Tray System allows routing of temporary Audio/Video cables along corridors and over doorways.
2. Unless specifically called out otherwise, all Audio/Video system wiring listed in the Audio/Video schedule of terminations shall be run in metallic conduit.

1.5 SUBMITTALS
A. The Electrical Contractor shall submit a conduit riser diagram for all Audio/Video system wiring.

PART TWO - PRODUCTS

2.1 GENERAL
A. All audio cable raceway products shall conform to the requirements of other Division 26 Sections.
B. No substitutions are allowed without the written authorization of the Electrical Engineer and the Audio/Video Designer.
2.2 METALLIC CONDUIT
   A. Subject to compliance with requirements, provide metallic conduit as specified in Section 260533.

2.3 PVC CONDUIT DUCT
   A. Subject to compliance with requirements, provide PVC conduit as specified in Section 260533.

2.4 CABLE SLEEVES
   A. Subject to compliance with requirements, provide cable sleeves as specified in Section 260533.

PART THREE - EXECUTION

3.1 INSTALLATION - GENERAL
   A. Prior to installation, the Electrical Contractor shall submit a riser diagram for all Audio/Video system conduit.
   B. No installation work shall proceed until the conduit riser has been approved, in writing, by the Electrical Engineer and the Audio/Video Designer.

3.2 INSTALLATION - WIRE GROUPS IN CONDUIT
   A. The Audio/Video location drawings and the Audio/Video schedule of terminations indicate the origins and destinations for all Audio/Video cables. The method of cable routing described in those documents indicates the maximum number of conduit runs required to install the Audio/Video systems.
   B. The actual diameter and path of each conduit run shall be determined by the Electrical Contractor in accordance with field conditions.
   C. Should the Electrical Contractor choose to combine cable runs from individual terminations into a common conduit, then they must conform to the wire grouping, conduit fill, and conduit separation requirements listed in this Section.
   D. To prepare the required conduit riser diagram, the Electrical Contractor must group cables by wiring type; determine the total number of cables in each conduit run; determine the diameter of each conduit run; determine the actual routing of each conduit run.
   E. Refer to Section 27 41 00 and the large format AV drawings for wiring group and conduit separation requirements.
   F. Refer to Section 27 41 00 and the large format AV drawings for Audio/Video cable specifications.

3.3 INSTALLATION - CONDUIT SEPARATION
   A. Audio/Video system wiring is divided into separate groups according to their nominal voltage levels. These wiring groups must never be intermixed within a given conduit run. See Section 27 41 00 and the large format AV drawings for wire type information.
   B. Conduits carrying Audio/Video wiring must maintain a minimum separation from conduits carrying other types of Audio/Video wiring. When necessary, ninety degree crossings in close proximity are acceptable. See Section 27 41 00 and the large format AV drawings for Audio/Video conduit separation requirements.
   C. Conduits carrying Audio/Video wiring must maintain a minimum separation from conduits carrying other types of electrical wiring. Unusually heavy current demands in; or long parallel runs with; electrical services may dictate greater separations to avoid interference with the Audio/Video system. See Section 27 41 00 and the large format AV drawings for electrical conduit separation requirements.
3.4 INSTALLATION - METALLIC CONDUIT SYSTEM
   A. The metallic conduit system is specified by information called out in the large-format Audio/Video system drawings:
      1. The location drawings indicate the position of each Audio/Video device and the method of mounting each device.
      2. The schedule of terminations lists each Audio/Video device; indicates the quantities, types, and groupings of all cables connected to each device; and lists the destination for all cables exiting each device.
   B. Refer to Section 27 41 00 and the large format AV drawings for audio cable specifications and conduit sizing requirements.
   C. In most cases, each run of this conduit system shall be bonded to the audio termination back boxes which are provided by the Audio/Video Contractor. The only exception is conduit which is routed to the audio equipment racks. Conduit runs entering or exiting the audio equipment racks shall be electrically isolated from the racks. PVC or other non-conductive fittings shall be used to isolate the conduit from the Audio/Video equipment racks.
   D. Provide all empty conduits with pull lines.

3.5 INSTALLATION - PVC CONDUIT/BEVWAY DUCT SYSTEM
   A. Install per architectural detail drawings.
   B. Provide all empty conduits with pull lines.

3.6 INSTALLATION - CABLE SLEEVES
   A. Install per architectural detail drawings with threaded cap at each end of sleeve. These caps shall be lubricated for easy removal and held captive by a chain.

3.7 INSTALLATION - CABLE TRAYS
   A. Wall mount cable trays shall be supported from underneath, not suspended from above.

END OF SECTION
SECTION 270010  
TELECOMMUNICATIONS GENERAL REQUIREMENTS

PART 1 GENERAL

A. Drawings
   1. The drawings must show the location of equipment racks and elevations, ladder rack on 3 walls, power outlet locations, general arrangement of equipment, electrical systems and related items. The installation will follow as closely as elements of the construction will permit.
   2. The drawings must show a conduit and cabling riser diagram from MDF and related IDFs. Copper pair and fiber strand counts will be detailed showing the distribution of riser cabling between the MDF and related IDFs.
   3. Deviations from the drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the architect/engineer and WSU C&IT.

1.2 INSPECTION OF SITE

A. Visit the site, examine and verify existing communications infrastructure conditions under which the work must be conducted before submitting proposal.
B. The submitting of a proposal implies that the Contractor has visited the site and understands the conditions under which the work must be conducted.

1.3 CONTRACT BREAKDOWN

A. WSU Facilities Department retains the installation and coordination for all projects initiated by that department. WSU C&IT retains the design review, installation and coordination for all other voice, data and video projects not initiated by WSU Facilities.

1.4 GUARANTEE

A. Contractor guarantees that the installation is free from defects and agrees to replace or repair, any part of this installation which becomes defective within a period of two year following final acceptance, provided that such failure is due to defects in the equipment, material or installation or to follow the specifications and drawings. File with the owner any and all guarantees from the equipment manufacturers and warranty certificates. FP&M will notify C&IT of substantial completion and deliver all warranty certificates, as-built and test results. This warranty will coincide with the project warranty.

1.5 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for telecommunications work shall be secured and paid for by the contractor. All work shall conform to all applicable codes, rules and regulations.
B. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed drawings or diagrams which may be required by the governing authorities. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.
1.6 STANDARDS OF MATERIALS AND WORKMANSHIP
A. All materials shall be new, never used, reused, reconditioned, or refurbished components. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:
- A.N.S.I. American National Standards Institute
- A.S.T.M. American Society for Testing Materials
- BICSI Building Industry Consulting Services International
- I.C.E.A. Insulated Cable Engineer’s Association
- I.E.E.E. Institute of Electrical and Electronics Engineers
- N.E.C. National Electrical Code
- N.E.M.A. National Electrical Manufacturer’s Association
- TIA Telecommunications Industry Association
- U.L. Underwriters Laboratories, Inc. NFPA National Fire Protection Agency
B. All equipment of the same or similar systems shall be by the same manufacturer.

1.7 RECORD DRAWINGS
A. Provide revised telecommunications working drawings indicating “as-built” conditions. Drawings shall indicate all changes that have occurred during construction. Properly and identify backbone and horizontal wiring pathways.
B. Locate all network and workstation devices. Identify all devices on plan with proper labeling. Identify outside plant backbone conduits, man holes and fiber cables installed on a site plan. “As-built” drawings shall be submitted on AutoCAD 2018 or newer electronic DWG file format.
C. Provide a site plan with elevations showing any manholes, handholes or conduit installed outside.

1.8 SHOP DRAWINGS/SUBMITTALS
A. All shop drawings shall be submitted in groupings of similar and/or related items (cable and connectors, equipment cabinets and racks, etc.). Incomplete submittal groupings will be returned unchecked.
B. Provide detailed layout shop drawings (on transparent media) of backbone and horizontal cabling distribution, pathways, equipment room layouts, details and related information necessary of installation and maintenance. After review by the Engineer and WSU C&IT, a copy of Drawings will be stamped and returned to the Contractor.
C. Submit for approval all telecommunications systems or equipment but not limited to the items listed below. Where items are referred to by symbolic designation on the Drawings and Specifications, all submittals shall bear the same designation. Refer to other sections of the Specifications for additional requirements.
   1. Structured cabling system components
   2. Structured cable system raceways and supports
   3. Outside plant cabling and components
   4. Outside plant ducts manholes, hand holes and conduit systems on a site plan with elevations.
   5. Equipment racks and cabinets including management components
   6. Labeling equipment
   7. Telecommunications grounding components
   8. Conduit, inner duct, junction and pullboxes
   9. Surface raceway components
   10. Manholes, hand holes and all accessories
   11. Telephone system components
   12. Data network system components
   13. Audio/video system components
14. Access control system components
15. Security Camera system components

1.9 CONTRACTOR BID ELIGIBILITY QUALIFICATIONS

A. The installing contractor for each communications system shall have a minimum of 5 years of experience with the types of systems specified. The company and employee must be certified to install, test and warranty the product specified. This certification must be produced at the WSU mandatory pre-bid meeting, prior to a bid submittal. No exception to this will be allowed.

B. The installing contractor may be asked to submit a reference list consisting of a minimum of 3 - 5 installations of equivalent size and complexity of this contract. The reference list shall contain the following information for each installation:
   1. Name of project, square footage, location and brief description of systems.
   2. Date of completed installation.
   3. Contact name and phone number of facility representative.
   4. Total bid amount of each system installed.
   5. Final contract amount of each system installed, including all change orders and bulletins.

C. The installing contractor shall submit with the bid the names and registration numbers of members of the firm that have a valid membership and are certified with BICSI as Registered Communications Distribution Designers (RCDD). This Contractor shall identify at least one RCDD assigned to this project in the bid and must be an employee of that company.

PART 2 – NOT USED

PART 3 EXECUTION

3.1 DESIGN VALIDATION

A. The bidding, shop drawing submittal, procurement of materials, the installation as-builds and record documents shall be reviewed and overseen by the RCDD(s) assigned to the project.

B. The Contractor’s bid, shop drawing submittals, as-builds and record documents shall bear the valid seal of the RCDD(s) assigned to this project.

C. All calculations, shop drawings, testing, certification and as-built documents shall be directly supervised by the licensed technician/engineer assigned to the project.

D. The sub-contractor must provide the general contractor a copy of the manufacturer’s certification that the sub-contractor is currently certified to install, test and warranty the proposed system prior to a bid submittal. See Section 27110, 7.5A and section 27010, 1.16A. The owner reserves the right to have the non-certified sub-contractor removed from the job.

3.2 INSTALLATION OF EQUIPMENT

A. Install all equipment in strict accordance with all installation specifications set by the equipment manufacturer. Where such directions are in conflict with the drawings and specifications, report such conflicts to the architect/engineer and WSU C&IT for resolution.

3.3 WORK PERFORMED BY OTHERS

A. Electrical contractor shall install 4” sq. sheet steel wall boxes, minimum 1” trade size conduit (or as indicated on drawings) stubbed 12” above ceiling with 6” radius (or as required by ANSI/TIA-569 C), with a 90-degree bend at top in the direction towards route destination, and plastic bushing for recessed locations.
B. Electrical contractor shall install 4” sq. cast boxes. Minimum 1” trade size conduit (or as indicated on drawings) stubbed up to 10’ AFF (or as indicated on drawings), with 6” radius (or as required by ANSI/TIA-569 C) for surface mounted locations.

3.4 DEMOLITION WORK

A. All demolition of existing telecommunications cable, equipment and materials shall be specified by C&IT and done by this contractor unless otherwise indicated.

B. Include all items such as, but not limited to, cable, patch panels, devices, and wiring back to the source, called out on the drawings and as necessary whether such items are actually indicated on the drawings or not in order to meet NFPA requirements.

C. In general, demolition of old low voltage communications cabling work is indicated on the drawings, however, the contractor shall visit the job site to determine the full extent and character of this work. All existing voice and data jacks demolished need to be documented. A room number, jack number (if still there), approximate location in the room and the communication room where it terminated need to be identified. This information must be returned to C&IT IOPS Networking Engineering Group.

D. None of the recovered material shall be reused in the new work.

E. Where new walls and/or floors are installed which interfere with existing telecommunications outlets, devices, etc., this contractor shall adjust, extend and reconnect such items as required to maintain continuity of same.

F. All electrical work in altered and unaltered areas shall be run concealed wherever possible. Use of surface metal raceway or exposed conduits will be permitted only where approved by the architect/engineer and as specifically indicated on the drawings.

3.5 WORK IN EXISTING BUILDINGS

A. Adequately protect and preserve all existing and newly installed work. Promptly repair any damage to same at this contractor's expense.

B. Consult with the owner's Project Coordinator and C&IT Project Coordinator as to the methods of carrying on the work so as not to interfere with the owner's operation any more than absolutely necessary. Accordingly, all telecommunications services shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the owner's representative.

3.6 COORDINATION

A. If there is a general contractor, the general contractor is responsible for the construction schedule. All work activities are to be coordinated with the general contractor.

3.7 CHASES AND RECESSES

A. Chases and recesses shall be provided by the architectural trades, but this contractor shall be responsible for coordinating their accurate location and size.

3.8 SLEEVES

A. Provide and install Hilti Speed Sleeve model CP-630 or EZ path fire stop system wherever conduits or cabling pass through fire rated walls, floors or cables pass through openings in walls Sleeves are used in standard walls and floors with no fire rating. All sleeves through the floor are to extend 4 inches above floor, unless otherwise noted. Provide escutcheons at each sleeve in finished areas and adequate spacing between sleeves to accommodate escutcheons.
3.9 ACCESS DOORS

A. Provide access doors for installation by architectural trades. In the walls, provide Milcor No. "DW" or "M" as required to make all controls, electrical boxes and other equipment installed by the Contractor accessible. Minimum size 12 inches x 12 inches. In the ceiling, provide Milcor No. 3210, 3105 or 3206 for accessibility as mentioned above, 24 inches x 24 inches minimum size. The plaster or acoustical tile insert shall be by the architectural trades. Areas with accessible ceilings (ceilings where tiles are not fastened in place and can be individually removed without removal of adjacent tiles) will not require access doors.

B. When access doors are in fire resistant wall or ceilings, they must bear the Underwriters Laboratories, Inc., Label, with time design rating equal to or exceeding that of the wall or ceiling unless they were a part of the tested assembly.

3.10 CLEANING

A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.

B. Final cleanup shall include, but not be limited to, cleaning all telecommunications equipment spaces, devices, cover plates, and removing all scrap cable and debris from pathways.

3.11 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

A. Newly installed network equipment shall be protected from theft, dust or damage while construction is going on.

B. Protect conduit openings with temporary plugs or caps.

C. Locks must be installed on communication room doors prior to any equipment installation.

3.12 EXTRA WORK

A. For any extra telecommunications work must be forwarded to the general contractor, an itemized breakdown of the estimated cost of the materials and labor required to complete this work. This contractor shall proceed only after receiving an impact report from the university establishing the agreed price and describing the work to be done. This doesn't amend the language of the main construction contract.

3.13 DRAWINGS AND MEASUREMENTS

A. Final as-built drawings must be delivered at project completion.

3.14 AUTOMATION SYSTEM PROGRAM CODE

A. All automation system uncompiled and compiled program codes, source codes, custom modules, graphical user interface screen shots and any other automation system programming data and material (Program Code) shall be provided to the university in hard copy and on CD-ROM in an unencrypted format acceptable to the university.

B. Copyright for the Program Code shall be assigned to the university for purposes of system maintenance.

C. Provision of and copyright assignment of the program code to the university by the vendor shall be conditions of the purchase order and contract acceptance by the vendor.

D. Provision of and copyright assignment of the program code to the university by the vendor shall be conditions of final system acceptance by the university.

END OF SECTION
SECTION 270110
TELECOMMUNICATIONS INTERIOR PATHWAYS

PART 1 GENERAL

1.1 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code
C. ANSI/TIA 568-C - Commercial Building Telecommunications Cabling Standard
D. ANSI/TIA 569-C - Commercial Building Standard for Telecommunications Pathways and Spaces
E. ANSI JSTD- 607 B - Commercial Building Grounding and Bonding Requirements for Telecommunications
G. BICSI – Building Industry Consulting Services International

1.2 SUBMITTALS

A. Submit all structured cabling system raceways and supports identified in this section under provisions of Section 270010.
B. Product data: Provide for products specified and required.
C. Shop drawings: Indicate project specific part numbers, dimensions, support points, fittings and finishes.

1.3 PROJECT RECORD DOCUMENTS

A. Submit all structured cabling system raceways and supports identified in this section under provisions of Section 270010.
B. Accurately record equipment layout and cable layouts in all telecommunication spaces.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of section 270010.
B. Protect products from corrosion and entrance of debris by storing above grade.
C. Provide appropriate covering.
1.5 PROJECT CONDITIONS

A. Verify that field measurements are as shown on drawings.
B. Verify routing and termination locations of conduits, and cable pathways prior to rough-in.

1.6 INSTALLATION OF CABLE SUPPORT SYSTEMS

A. Communications cabling systems pathways shall be installed in accordance with ANSI/TIA 569-C.
B. Intra-building backbone cabling shall be installed in conduit, cable tray or J-hook support system.
C. Horizontal cabling (cabling from the telecommunications room to the work area outlet) pathways shall consist of conduit, cable tray, J-hooks, and accessible ceiling space as indicated on drawings and as required.
D. Where the accessible ceiling systems are used as the primary pathway, cabling shall be installed in main cable tray runs as indicated on the drawings and in J-Hooks, with individual work area cables routed exposed in conduit and supported as specified herein.

PART 2 PRODUCTS

2.1 J-HOOKS

A. Manufacturers:
   1. Erico-Caddy.
   2. B-Line.
B. Horizontal cable routed exposed through ceiling space shall be supported from J-hooks.
   1. J-hooks shall be a minimum of 5/8" wide and shall have a bearing surface that complies with required bend radii of the specified cables to be supported.
C. Inner duct
   1. Install inner duct through conduits and sleeves for optical fiber cabling installations.
   2. Description: UL listed, non-metallic, corrugated flexible conduit for use in plenum or riser installations as applicable. Provide each inner duct with one 1/4" W pull tape with a tensile rating of 900 lbs.

PART 3 EXECUTION

3.1 GENERAL

A. Where cables pass through fire rated walls, the contractor shall provide and install Hilti Speed Sleeve model CP-630 or EZ path fire stop system. This penetration sleeve must match the fire rating of the wall. The penetration shall be sized per ANSI/TIA-569-C.
3.2 ANY OTHER WALL OR FLOOR PENETRATIONS THAT AREN'T FIRE RATED, THE CONTRACTOR SHALL FIRE-STOP THE PENETRATIONS, AFTER FINAL CABLE INSTALLATION, USING ENGINEER-APPROVED MATERIALS. FIRE-STOPPING MATERIALS SHALL BE INSTALLED PER MANUFACTURER'S RECOMMENDATIONS AND SHALL MAINTAIN PARTITION RATING AND INTEGRITY. ALL FIREPROOFING SHALL BE APPLIED IN A NEAT MANNER WITH ALL EXCESS MATERIAL CLEANED FROM ALL WALLS AND SURFACES. CONTRACTOR SHALL REPLACE AND RE-INSTALL ALL FIREPROOFING MATERIALS REMOVED DURING CABLE INSTALLATION.

A. Contractor shall patch and repair any holes or other damage to walls or partitions and paint to match original, as applicable.

B. The communication cabling contractor shall provide plastic and/or grounding bushings, as applicable, on all conduit sleeves, stubs and conduit terminations that may have been missed by the electrical contractor.

C. All cutting, patching and restoration to the original condition of walls, ceilings, floors, etc., shall be the responsibility of the contractor.

D. All ceiling removal and restoration required for the execution of this work shall be the responsibility of the contractor.

E. Any additional existing voice and data jacks demolished need to be documented. A room number, jack number (if still there), approximate location in the room and the communication room where it terminated need to be identified. This information must be returned to C&IT Customer Services Telecommunications department.

F. All cabling installed exposed in accessible ceiling systems shall be supported by cable tray or J-hooks.

G. All J-hooks shall be supported directly from the structure above or wall mounted, as applicable, independent of ceiling framing, electrical conduit, mechanical piping and ductwork. Provide all-thread rod with minimum ¼” diameter or equivalent supporting means with suitable fasteners when attaching to structure or structural members. Increase size of support as required when multiple J-hooks (stacked or tree configuration) are attached to single support based on maximum loading capacity of J-hooks.

H. J-hooks shall be spaced 48” maximum on center.

I. Telecommunications cabling shall be routed in continuous conduit above hard ceilings or between floors in any kind of offset condition.

J. Communications cable pathway routing shall be coordinated with above ceiling work of other contractors to avoid conflicts and potential sources of EMI.

K. Do not route exposed communications pathway within 12” of lighting fixtures and electrical power feeders.

L. Route inner duct for all fiber optic backbone cabling, in cable tray, conduit, and sleeves. Coordinate routings and quantities with drawings.

END OF SECTION
SECTION 270130
COMMUNICATION EQUIPMENT SPACES SUPPORT HARDWARE

PART 1 GENERAL

1.1 REFERENCES

B. NFPA-75 - Protection of Electronic Computer Data Processing Equipment.

1.2 SYSTEMS

A. ANSI/TIA 568-C - Commercial Building Telecommunications Cabling Standard.
B. ANSI/TIA 569-C - Commercial Building Standard for Telecommunications Pathways and Spaces.
C. ANSI/TIA 607-B - Commercial Building Grounding and Bonding Requirements for Telecommunications.
E. BICSI – Building Industry Consulting Services International.

PART 2 PRODUCTS

2.1 TWO POST EQUIPMENT RACKS

A. Manufacturers:
   1. Chatsworth Products (CPI)
   2. Homaco
   3. Hubbell
B. Description: Nominal 19” x 84”H equipment rack, with universal EIA hole spacing for mounting equipment and accessories.
C. Material: 6061-T6 heavy-duty aluminum or equivalent.
D. Provide all hardware for floor mounting and anchoring.
E. Provide one (1) equipment shelf and all mounting hardware.

2.2 POWER STRIPS EQUIPMENT RACKS

A. Manufacturers:
   1. APC – Model APC 8841
   2. Triplite – Model PDU30HV3HV2
B. Provide one 208-volt, 30-amp, single phase power strip for each rack installed.
C. Install one 208-volt, 30-amp, single phase power strip on each equipment rack.
D. Mount vertical on side of rack.
E. No Velcro mounting allowed.
F. Plug mates with a L6-30 receptacle.
G. Install the power strip with a 6 to 10-foot cord.
H. Include a temperature and humidity Sensor
I. Provide one 120-volt 20-amp dedicated power circuit for each equipment rack.
J. Provide one 120-volt 20-amp “metered” PDU for each 120-volt circuit.
K. Provide four additional 120-volt 20-amp service outlets, one on each wall.
L. Use factory mounting hardware on the equipment rack whenever possible.

2.3 VERTICAL CABLE MANAGEMENT
A. Manufacturers:
   1. Same as manufacturer of equipment rack.
B. Description:
   C. Duct style cable management panel for mounting on equipment racks with slotted construction to allow multiple cable exits, double sided for front and rear management and fluted to allow cables to pass from front to rear.
   D. Removable solid cover.
   E. Material: ASTM A569 steel or 5052-H32 aluminum.
   F. Provide 10" Wide cable management units between racks and one 6" Wide at ends. Cable management unit shall be 84"High by nominal 6" Deep.
   G. Finish: Electrostatic powder coat, post-fab painted in black.
   H. Provide all hardware required for securely mounting panel to equipment rack.

2.4 HORIZONTAL CABLE MANAGEMENT
A. Manufacturers:
   1. Chatsworth
   2. Homaco

2.5 EQUIPMENT CABINETS
A. Manufacturers:
   1. Chatsworth Products (CPI)
   2. Hubbell.
   3. Great Lakes Cabinets.
B. Standard equipment cabinet, floor mounted, will be nominal 24" W x 30" D x 84" H, fully welded steel construction, lockable front and rear doors (roof fans) cable management, 19" EIA mounting racks and adjustable, fixed shelves as required.
C. The top cover shall accept the mounting of a 250 CFM cooling fan.
D. The cabinet shall be pre-configured for 19" mounting with universal hole spacing per the EIA 310 standard requirements.
E. The cabinet shall feature three sets of rails, front, center, and rear. The front set of rails shall be 20 rack positions high, from the bottom of the cabinet. The rear and center rails shall be the full internal height. The recess of all three sets of rails shall be adjustable forward and back. The rails shall be tapped for a #10-32 screw. The center rails shall be formed in a ‘C’ profile, 3” deep, tapped on both the front and rear flanges so as to provide the functionality of an open frame rack. The front and rear rails shall be of an L shape.
2.6 WALL-MOUNTED EQUIPMENT CABINETS

A. Manufacturers:
   1. Chatsworth Products (CPI)
   2. Hubbell.
   3. Great Lakes Cabinets.

B. Wall mount equipment cabinets shall only be installed where floor space for equipment racks is not available.

C. Equipment cabinet, wall mounted will be nominal 24” W x 48” H x 24” D, with equivalent construction as standard floor mounted cabinet except with double hinged center section.

D. Load capacity of the cabinet shall be 150 lbs.

E. Provide dedicated 120V circuit installed in cabinet.

2.7 BACKBOARDS

A. AC-grade fire rated or better plywood backboard in sheets measuring 4’ W x 8’ H x 3/4”D. Plywood sheets shall be flat and free of all voids. Do not paint the plywood. This voids the fire rating.

2.8 TELECOMMUNICATIONS CABLE RUNWAY

A. Manufacturers:
   1. Chatsworth Products (CPI)
   2. Homaco.
   3. Hubbell.

B. Description: 16-gauge tubular steel stringer style, with rungs 9”-12” O.C.

C. Material: 3/8” x 1-1/2” tubular steel with 1/2” x 1” steel channel rungs, or equivalent.

D. Width: As indicated on drawings.

E. Cable runway must be mounted from the sides. It is not permissible to support the cable runway from the center. No exception to this will be allowed.

PART 3 EXECUTION

3.1 EQUIPMENT RACKS

A. Contractor shall furnish and install wall mounted and floor-mounted equipment racks per manufacturer’s recommendation.

B. The racks shall be labeled according to the drawings and in accordance with specification 270170 “Cable Plant Administration and Testing.”

C. Free standing equipment racks shall be bolted to the floor using anchors in concrete floor and toggle bolts through raised flooring.

D. All racks, cabinets and cable transport hardware shall be bonded to the communications system ground riser.

E. Mount the top of two post equipment racks to the bottom of cable runway for equipment rack support strength and cable flow into equipment rack.

F. All equipment racks and cable runway must be grounded and bonded per BICSI standards.

3.2 CABLE MANAGEMENT

A. Install vertical cable management panels per communication room specifications.
B. Install vertical panels on each side of free-standing equipment racks.

3.3 BACKBOARDS
A. Three walls in communication rooms shall be covered with plywood backboards. A minimum 8’-6” above finished floor.
B. Normally, no plywood is needed on the wall where the door is.

3.4 TELECOMMUNICATIONS CABLE RUNWAY
A. As a minimum, mount runway at each end to wall using appropriate hardware.
B. Where overall length is greater than 10 ft, provide supplemental support from structure above or from equipment racks and cabinets below.
C. Mount runway directly to top of racks unless noted otherwise on drawings for the cable runway to be higher.
D. Runway shall run around 3 sides of perimeter of room and an additional 4th section across the center of the room securing the top of the equipment racks to the cable runway. Normally no cable runway will be needed on the door side wall unless cable sleeves / cable tray entering the communication room are over the door header or noted otherwise on the drawings.

END OF SECTION
SECTION 270150
TELECOMMUNICATIONS CABLELING

PART 1 General

1.1 REFERENCES

C. FCC Part 68 - Connection of Terminal Equipment to the Telephone Network.
D. FCC Part 15 - Radiation Limits
E. FCC Part 76 - Cable Television Service.

1.2 PROJECT CONDITIONS

A. Verify field measurements are as shown on drawings.
B. Verify suitability of all pathways prior to cable installation.

1.3 CABLELING SYSTEM PERFORMANCE

A. General:

1. Cabling system performance shall meet or exceed current industry standards and/or manufacturers’ specifications as specified herein.
2. The cable installed in the walls, connectors, jack, patch panels, and patch cords must be the same manufacture and model that forms the complete cabling system channel. The total system shall meet the performance criteria described below.
3. The cable and connector devices shall be certified compatible by the manufacturer of each component to meet the performance criteria described below. Submit manufacturer’s certification with submittals.
4. The referenced standards describing the performance below shall include all revisions, clarifications and bulletins to the original standard referenced as well as any standards cross-referenced.
5. The referenced standards describing the performance below shall apply to backbone cable, horizontal cabling and connecting hardware performance requirements as well as installation standards and techniques and field testing and verification of performance.
6. A plenum category 5 (CAT5E) cabling in a 25 pair cable bundle is to be utilized for voice (Analog Gateway connected telephone) building backbone riser only. Category 5 performance is defined by ANSI/TIA 568-C for 100-ohm UTP cables and associated connecting hardware whose transmission characteristics are specified up to 100 MHz.
7. Category 6 enhanced (CAT6E) cabling shall be utilized for all voice, data, wireless access points and security camera horizontal wiring. For WSU projects, any one of the following five cat6e structured cabling system products are acceptable:
a. Hubbell NEXTSPEED Cat 6 enhanced
c. Superior-Essex/Ortronics NextGain Cat6EX
d. Beldon DataTwist 600e
e. CommScope Uniprise 7504 Cat6E

1) Category 6e performance is defined by the manufacturers of the above cabling products.

8. Fiber optic cabling shall be utilized for all data building backbone riser. Fiber optic performance is defined as follows:
   a. Multimode: 50/125µm laser optimised fiber optic cable. The cable shall be dual rated for 850nm and 1300nm and meet all performance requirements of TIA/EIA 568-492aaac (OM3) at each transmission wavelength.
      1) Maximum attenuation:
      2) 3.5dB/km @ 850nm
      3) 1.5dB/km @ 1300nm Bandwidth:
      4) 1500 MHz*km @ 850nm
      5) 500 MHz*km @ 1300nm
   b. Singlemode: Provide nominal 9/125µm core/cladding, singlemode dispersion un-shifted fiber optic cable. The cable shall be rated for 1310nm and 1510nm and meet all performance requirements of
      1) ANSI / TIA 568-C at each transmission wavelength.
      2) Maximum Attenuation:
      3) 0.5dB/km @ 1310nm
      4) 0.5dB/km @ 1550nm Bandwidth:
      5) 2GHz*km @ 1310nm
      6) 2GHz*/km @ 1550nm

1.4 CONTRACTOR QUALIFICATIONS

A. The installing contractor shall be certified by the cabling and connector manufacturer of the structured cabling system product selected. A letter of certification from the manufacturer must be included with the bid submittal. No exception to this will be allowed.

1.5 SUBMITTALS

A. Product Data Sheets

1. Submittals can be sent electronically to WSU project managers.
2. The binders shall contain manufacturer’s product data sheets for the specific items to be installed for this project.
3. The Contractor shall indicate specific color, style, configuration, etc., and all accessories specified and required for a complete installation.

1.6 UTP CABLING SYSTEM WARRANTY

A. General

1. The UTP voice and data cabling system is warranted by the manufacturer(s) “Application Warranty” of the components for a period of not less than 20 years from the time the installation is deemed complete, provided certified installation and testing is followed.
2. It shall be the sole responsibility of the low voltage cabling Contractor to register the project with the manufacturer(s) and meet all manufacturers’ “Application Warranty” requirements.
3. It shall be the sole responsibility of the low voltage cabling Contractor shall provide Owner with test results, all manufacturers' warranty certificates with Record Documents including a site plan elevation with outside plant man holes, hand holes and conduit.

1.7 WARRANTY COVERAGE

A. Product - all passive components of the cabling system shall be warranted to be free from defects in material and workmanship for the entire duration of the warranty.

B. Paint or any other material on the UTP cable voids the warranty. If this can’t be removed during the installation, the effected cables will need to be replaced.

C. Any UTP CAT6e cable or component that has been painted and / or not satisfactorily passing tests or failing to meet quality installation standards as described in the standards will be repaired or replaced as directed by C&IT Network Engineering Group at the contractor’s expense.

1.8 WARRANTY REQUIREMENTS

A. Provide a channel warranty for all data drops.

B. Warranty shall cover repair or replacement of all defective components free of charge, including all labor performed by a manufacturer-certified installer. All new or replacement components shall be furnished new. Never used, reused, reconditioned, or refurbished components are allowed by the manufacture.

C. The installing contractor must be certified by the cabling and connector manufacturers as an approved and trained installer of their equipment.

PART 2 PRODUCTS

2.1 INTER-BUILDING FIBER OPTIC BACKBONE

A. Singlemode fiber optic cabling

B. Manufacturers:
   1. Systimax
   2. Corning
   3. BerkTek
   4. CommScope

C. Description:
   1. Nominal 9/125 µm, strand counts as indicated on drawings, loose tube, all-dielectric cable, rated for outdoor use. Cable shall have water-blocking properties to prevent water penetration and fiber damage. Cable shall have maximum 12 stands per tube, and an overall Polyethylene jacket.
   2. Nominal 9/125 µm, strand counts as indicated on Drawings, loose tube, OFNR rated for indoor/outdoor use. Cable shall have water-blocking properties to prevent water penetration and fiber damage. Cable shall have maximum 12 stands per tube, and an overall UV resistant, flame retardant jacket.

2.2 INTRA-BUILDING COPPER BACKBONE (VOICE ONLY)

A. Manufacturers:
1. Superior-Essex
2. BerkTek
3. Beldon
4. Hubbell
5. CommScope

B. Description:
1. Twisted pair copper conductors, 24 AWG, solid annealed copper.
2. Provide pair counts as indicated on Drawings.
3. Cable rated CAT5E voice backbone cable, UL Listed CMP as required.
4. 25 pair binder groups color coded per industry standards.
5. Flame-retardant PVC insulation for riser rated applications, low-smoke PVC insulation for plenum applications, color-coded for each conductor per industry standards.
6. White, flame-retardant PVC outer jacket for riser rated applications, gray low-smoke PVC outer jacket for plenum applications.

2.3 INTRA-BUILDING FIBER OPTIC BACKBONE

A. Multimode fiber optic cabling
1. Manufacturers:
   a. Systimax
   b. Corning
   c. BerkTek
   d. CommScope
2. Description: 50/125 µm OM3, strand counts as indicated on Drawings, tight buffered, OFNP. Cable shall be comprised of individually jacketed, and uniquely identified fibers with an overall aqua sheath.
3. Horizontal and Vertical fiber cable shall be furnished with performance requirements for the system served (voice, video or data) as indicated on the drawings riser diagram.

B. Singlemode fiber optic cabling
1. Manufacturers:
   a. Systimax
   b. Corning
   c. BerkTek
   d. CommScope

C. Description: Nominal 9/125 µm, strand counts as indicated on Drawings, tight buffered, OFNP. Cable shall be comprised of individually jacketed, and uniquely identified fibers with an overall yellow sheath.
1. Horizontal and Vertical fiber cable shall be furnished with performance requirements for the system served (voice, video or data) as indicated on the drawings riser diagram.

2.4 COPPER HORIZONTAL CABLING

A. Manufacturers:
1. CommScope
   a. BerkTek
   b. Superior-Essex
   c. Hubbell
   d. Beldon

B. Description:
1. Horizontal cable shall be furnished with performance requirements for the system served (voice, video or data) as indicated on the drawings riser diagram.
2. Category 6 enhanced: 23 AWG, 4-pair, 100 ohm, UTP, CMP, with green jacket for data and wireless access points, yellow jacket for voice cabling, purple jacket for security camera cabling.

3. Workstation, server, printer etc. data jacks will terminate in their own group of patch panels. Wireless access point and security camera data jacks will terminate in their own separate group of patch panels. All patch panels are installed in the equipment racks.

2.5 UTP JACKS AND CONNECTORS

A. Manufacturers:
   1. CommScope UNJ600.
   2. Ortronics
   3. Leviton
   4. Hubbell
   5. Beldon

B. Modular jacks for UTP cables:
   1. 8 position, 8 conductor, non-keyed, universal modular jack, snap-in type, terminated with a 110 style pc board connector, color coded for T568A and T568B wiring.
   2. Designed to terminate 22-26 AWG solid on insulation-displacement
   3. 110-style connectors.
   4. Contacts shall be minimum 50 micron gold-plated in the contact area.
   5. Rated to match the performance of the cabling system they are installed on.
   6. Color coded for system served as indicated on the Drawings.
   7. Furnish keystones (icons) for jack identification. Keystones for voice, data, wireless access points and security cameras jacks shall be orange.
   8. When installing outdoor cameras, APs, or any type of network device, you must use one of the following Hi-Impact jacks and patch cords.

C. Manufacturers:
   1. CommScope UMP610-24P or UMP610-48P.
   2. Ortronics
   3. Leviton
   4. Hubbell HI6Coupler and Jack. HI603AE Patch Cord
   5. Beldon

D. When installing outdoor cameras, APs or any type of network device, you must use one of the following CAT6E POE compatible lightning, surge protection devices part of the communication room termination:

E. Manufacturers:
   1. ATLAN AT-2210
   2. Phoenix Contact DT-LAN CAT.6+ 2281007
   3. L-COM BT-CAT6-P1-HP

F. UTP patch panels

G. Manufacturers:
   1. CommScope UMP610-24P or UMP610-48P.
   2. Ortronics
   3. Leviton
   4. Hubbell
   5. Beldon

H. UTP patch panel
   1. Patch panel shall serve as data jack, voice jack, security camera and wireless access point system horizontal cross connect.
2. Wireless access point and security camera data jacks will be terminated on their own patch panel separate from the workstation data jack patch panels.
3. Patch panel shall be configured for standard 19” rack mounting.
4. High density type with snap in 24 modular jack ports for every standard rack mount unit (1.75” high).
5. Maximum 6 port groupings of replaceable modules.
6. Terminations for the “building side” cabling on 110-style insulation PC board connectors color-coded for T568B terminations.
7. Horizontal and vertical cable management hardware front and rear.
8. Performance shall meet the performance of the cabling system they are installed on.
9. Constructed of black anodized aluminum with adequate structural integrity so that panel will not deflect when center of panel is pushed with the hand.
10. Provisions for icons and labeling to comply with the labeling requirements in specification 27170, "Cable Plant Administration and Testing".

2.6 CROSS-CONNECT BLOCKS

A. Manufacturers:
   2. Ortronics
   3. Leviton
   4. Hubbell
   5. Belden

B. Cross-connect blocks
   1. Cross connect blocks shall be used for voice connectivity backbone to horizontal cross connects:
   2. Wall-mount 110-type wiring blocks mounted in a modular frame if needed.

2.7 FACE PLATES

A. Manufacturers: Same as jacks and connectors, unless otherwise noted. In almost all cases in labs, stainless steel plates will be called out in lieu of plastic. Reference construction drawings.

B. Face plates for wall mounted workstation outlets shall allow a minimum 2 and maximum of 6 positions and accept snap-in jacks, as specified.

2.8 UTP PATCH CORDS

A. Manufacturers
   1. Shall be the same manufacturer and type as the cable, jacks and patch panels installed in the building.

B. Description
   1. Provide one (1) 1’ patch cord for each data port installed in the patch panel. Provide one (1) 1’ patch cord for each data port installed at the workstation area.
   2. For the workstation room side provide patch cords with stranded conductors and jacketing for greater flexibility.
   3. Patch cords shall be gray color for the workstation, and communication room areas. Patch cords shall be green color for the access point. Patch cords shall be purple color for the security cameras. Coordinate possible different lengths with C&IT.

2.9 FIBER OPTIC CONNECTORS FOR BOTH INTER–BUILDING AND INTRA–BUILDING CABLES

A. Manufacturers:
1. Corning Cable Systems.

B. Multimode OM3 fiber optic connectors shall be:
   1. Field installed LC type in 12/24 port panels for INTRA – BUILDING riser tie cabling between communication rooms. Provide aqua color connector.

C. Single-mode fiber optic connectors shall be:
   1. Field installed LC type in 12/24 port panels for INTRA – BUILDING riser tie cabling between communication rooms. Provide blue color connector.
   2. Field installed LC type in 144 port panels for INTER – BUILDING tie cabling between buildings. Provide blue color connector.

D. Single-mode fiber optic connectors for video shall be:
   1. Field installed LC/APC type in 12/24 port panels for INTRA– BUILDING riser tie cabling between communication rooms. Provide green color connector.
   2. Field installed LC/APC type in 12/24 port panels for INTER – BUILDING tie cabling between buildings. Provide green color connector.

E. Connectors shall be epoxy polish LC/APC type with ceramic ferrule with tool kit.

F. Connectors shall be fusion type. Compression type connectors shall not be allowed.

G. All LC/APC connectors and ferrules shall be green in color.

H. Field Install a Minimum of 2 strands (last 2) or coordinated exact quantities and requirements for LC/APC terminated fiber optic strands with C&IT-IT Customer Services- Telecommunications department prior to installation.

2.10 FIBER OPTIC PATCH PANELS

A. Manufacturers:
   2. Corning
   3. Leviton
   4. Ortronics

B. Description
   1. Rack-mounted, minimum 12-port Maximum 96-port patch panel with modules or panels.
   2. Use factory terminated fusion splice LC pig tail type connectors.

PART 3 EXECUTION

3.1 GENERAL

A. In addition to the notes contained on the Drawings, the following Contractor notes shall apply.

3.2 CABLE ROUTING

A. Route all cables and cable raceways parallel to or perpendicular to building structure.

B. All cables shall be installed as single continuous "home-run" pulls from connector block to connector block, or from patch panel in the telecommunications room to the data workstation outlet in the work area.

C. Cable that is run above a suspended ceiling must be supported per NFPA code requirements. Three choices are, conduits, cable tray or by J-hooks.

D. No tie-raps or bundling allowed.
E. The maximum spacing of cable hangers, supports and the number of data cables per hanger shall not exceed BICSI specification.

F. The installation contractor shall be responsible to replace all fire-proofing materials required for the installation. Any missing fire-proofing materials shall be reported to WSU for repair to maintain required fire rating of structure.

G. Communication cable and infrastructure shall be independently supported.

H. Do not support or tie-wrap any cables to ductwork, plumbing lines, fire suppression, electrical conduits, mechanical systems, or ceiling system.

I. Do not route cables through block wall without a sleeve, directly lay data cables on ductwork, piping and plumbing systems or on top of the lay-in ceiling tile.

J. All cable must be free of tension at both ends as well as over the length of the run.

K. Only Velcro straps are permitted as cable bundle supports. Waterfalls from cable tray shall not pinch, bind, crimp or in any way deform or cause physical damage to the cable jacket, or alter the electrical characteristics of the data cables.

L. Contractor shall take care to assure that during and upon completion of the installation, all cables are free of kinks, sharp bends, twists, gouges, cuts or any other physical damage which may cause physical or electrical characteristic alterations to the cables. The cables must also be installed at the proper room temperature. Any of these conditions will constitute a replacement of the installed cable.

M. Contractor to observe all minimum bend radius and tension limitations, etc., as specified by the cable manufacturer when installing the cables.

N. Contractor shall supply neatly bundled slack loops of length 10 feet for all cabling in telecommunications spaces. Provide neatly bundled slack loop 1 foot above the ceiling at workstation end.

O. Provide Velcro cable ties periodically in all runs and within the telecommunications spaces provide slack loops per BICSI standards.

P. Route all optical fiber cabling in inner duct. Armored fiber cable doesn’t need to be in innerduct. Support inner duct with j-hooks a maximum five feet on center when not routed in conduit or cable tray.

3.3 CABLE TERMINATIONS

A. The contractor who installs the communications cabling must be the one who terminates the communications cabling and test the finished data channel. It is not allowed to have a non-certified electrical contractor install the communications cable and have another certified contractor terminate, test and warranty it. No exceptions to this will be allowed. Terminate all wiring at both ends using the T568B convention. All voice and data cables shall be terminated in accordance with ANSI/TIA 568-C installation guidelines.

B. Terminate all wiring at both ends using the T568B convention. All voice and data cables shall be terminated in accordance with ANSI/TIA 568-C installation guidelines.

C. All data cables shall be terminated on rack mounted, high density, patch panels.

D. Wireless access points, security cameras and all other “internet of things” data jacks will be terminated on their own patch panel separate from the workstation data jack patch panels.

E. All data jacks above ceiling must be orange, securely mounted and labeled. No free floating or double stick mounted jacks are allowed.

F. All cable terminations shall be free of stress or tension when complete.
3.4 OUTLETS  
A. Data jacks are installed in outlet boxes on the wall, approved raceways or directly wired and mounted cubical furniture.

3.5 FACE PLATES  
A. Contractor shall provide standard faceplate with blank inserts for all outlets indicated as "future".

3.6 PATCH PANELS  
A. Mount patch panel according to equipment rack elevations.

3.7 VOICE RISER CONNECTING BLOCKS  
A. If needed, mount 110 style-connecting blocks on plywood backboard.  
B. Provide “D rings” and cable management between blocks.

END OF SECTION
SECTION 270170
CABLE PLANT ADMINISTRATION AND TESTING

PART 1 GENERAL

1.1 REFERENCES
C. ANSI/TIA 568-C - Commercial Building Telecommunications Cabling Standard
D. ANSI/TIA 569-C - Commercial Building Standard for Telecommunications Pathways and Spaces.
E. ANSI/JSTD 607-B - Commercial Building Grounding and Bonding Requirements for Telecommunications.

PART 2 PRODUCTS

2.1 LABELS
A. Manufacturers:
   1. Brady.
   2. Brother P-Touch.
   3. Equivalent by Tester manufacturer.
   4. Equivalent by UTP connectivity manufacturer.

B. Description
   1.1. Machine-printed permanent glossy polyester labels for racks, cabinets, faceplates, and panels. (Brady B-422).

C. Machine-printed, self-laminating vinyl for cabling and patch cords. (Brady B-427)

PART 3 EXECUTION

3.1 LABELING
A. Contractor to install all faceplate and equipment labels in accordance with manufacturer’s recommendations and the specifications. All labels shall be neatly installed and shall be level with the floor and properly aligned on the faceplate.

B. All pieces of voice and data equipment, including wires, cables, fibers and their respective terminations shall be labeled and identified in accordance with ANSI/TIA 606- B.

C. Labels shall meet the requirements of UL 969 as outlined in the ANSI/TIA 606-B.

D. All horizontal and backbone subsystem copper and fiber cables shall be labeled at each end. Labeling is required at intermediate points such as pullboxes and consolidation points (where appropriate).

E. Do not install labels closer than 3” to the termination point.

F. Patch panel labels shall be printed with the associated user data jack number.
G. Contractor shall submit a sample of patch panel label strips to the Engineer for approval prior to installation.

H. Numbering schemes for fiber panels, copper patch panels and voice wall 110 punch blocks will go in ascending order.

I. Intra-building fiber riser cable labeling scheme is for building riser cables between communication rooms, [cable type] - [WSU Building Number] - [floor number] - [communication room number]. Example: BRC-027.03.315

J. Voice and data jack labeling scheme is [Room Number] – [jack number + function]. Ex: 222-V01, 222-D01, 222-V02, 222-D02, 223-V01, 223-D01, etc

K. Labeling shall be consistent at each end of cabling and at workstation outlet and patch panel or connecting block. Data jacks shall be orange located in the outlet bottom position (vertical) or the outlet right position (horizontal). Voice jacks shall be White located in the outlet top position (vertical) or the outlet left position (horizontal). All voice terminates in their own patch panel.

L. Wireless access point jacking labeling scheme is [WAP] - [Room Number]. If the access point is in a corridor, use the closest room number. Labeling shall be consistent at each end of cabling and at WAP outlet and patch panel or connecting block. When a wireless access point is located above the ceiling a label must be placed on the ceiling grid which contains a small red dot and the wireless access point jack number.

M. Security camera jacking labeling scheme is [CAM] - [Last 2 octets of the IP Number]. Elevated cameras must have labeling at the bottom which allows for viewing from ground level. Labeling shall be consistent at each end of cabling and at WAP outlet and patch panel or connecting block.

N. All access point and security camera jacks will be terminated together on their own patch panel separate from the workstation data patch panels.

O. Outdoor fiber cables must be labeled with WSU fiber ownership cable label and unique building or backbone fiber cable name.

P. All labels must be based on the final room numbers. Verify room numbering with Owner prior to installation of labels. Do not use room numbers that appear on construction drawings.

3.2 UTP SYSTEM TESTING

A. Upon completion of the cable installation, the Contractor shall perform complete copper cable certification tests, according to all manufacturer’s requirements for application warranty, testing required by TIA/EIA, including, but not limited to:
   1. Continuity checks on each cable, checking for opens and shorts.
   2. Cable length (Channel and Permanent Link).
   3. Correct pair polarity.
   4. Correct cable labeling at both ends.

B. Tests shall be performed with connectors installed.

C. Any UTP CAT6 cable or component that has been painted and / or not satisfactorily passing tests or failing to meet quality installation standards as described in the specification, shall be repaired and/or replaced as directed by C&IT Network Engineer at the Contractor's expense.

D. The Contractor shall prepare complete cable test reports for all installed cables for review and acceptance by WSU C&IT Network Engineering prior to acceptance and / or use of the cabling system.

E. Category 6E UTP cable patch cords shall be manufacturer made, fully tested and verified in accordance with product specifications. No field made patch cords.

F. All cable testing shall be conducted by a certified technician using a Level III minimum Fluke Networks DSX 8000, or C&IT Network Engineering approved equivalent certification tester.
G. The cable tester calibration must be up to date. Test results must have the operator with company name, WSU building project name and cable type field. The cable type field identifies the cable product type installed and tested.

H. The test results must be submitted in one file to C&IT for approval.

I. The Category 6E Horizontal Cable Certification reports shall have complete testing of channel for voice and data drops, at frequency increments up to 450MHz and set the

J. Cable length limit to 295’ as indicated in ANSI/TIA-568-C and test results will show the following:
   1. Cable ID Number which matches faceplate numbers and patch panel numbers
   2. Tester Calibration Validation Date. Has to be calibrated every year.
   3. Building Project Name, Test Date, operator and company names.
   4. Cable Length
   5. Wire-Map
   6. Network Tests for 100BASE-TX and 1000BASE-T
   7. Attenuation
   8. Near End CrossTalk (NEXT)
   9. Power-sum NEXT (PS-NEXT)
10. Attenuation to Cross Talk Ratio (ACR)
11. Power-sum Attenuation to Cross Talk Ratio (PS-ACR)
12. Equal Level Far End CrossTalk (ELFEXT)
13. Power-sum Equal Level Far End CrossTalk (PS-ELFEXT)
14. Return Loss
15. Propagation Delay
16. Delay Skew
17. Signal to Noise Ratio

K. Upon completion, before final payment the following must be provided:
   1. Provide (1) electronic copy of test results in PDF file format.
   2. Provide the manufacture warranty certificate upon completion.
   3. Test date.
   4. Tester make, model and calibration date.
   5. No exception to this will be allowed.

L. After the horizontal cable tests have been performed, the Contractor shall install the faceplate labels and modular jack dust covers.

3.3 OPTICAL FIBER SYSTEM TESTING

A. Upon completion of the fiber cable installation, the Contractor shall perform complete fiber cable certification tests, according to all manufacturer's requirements for warranty and all testing required by ANSI/TIA-568-C.

B. Test all multimode fiber (100%) using a power meter using the encircled flux testing criteria as stated in the TIA TSB-4979 specification or TIA 526-14-B standard, testing all cables in both directions.

C. Test all singlemode fiber (100%) using a power meter as per the TIA/EIA-526-7-A standard, testing all cables in both directions.

D. Provide test report and include as a minimum the following information for all cables:
   1. Fiber cable number
   2. Fiber length.
   3. Attenuation (loss in dB).
   4. Test date
   5. Tester make and model no.

END OF SECTION
SECTION 270536
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Wire-mesh cable trays.
   2. Cable tray accessories.
   3. Warning signs.
B. Related Requirements:
   1. Section 078400 “Firestopping” for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
   2. Section 260536 “Cable Trays for Electrical Systems” for cable trays and accessories serving electrical systems.
   3. Section 260526 “Grounding and Bonding for Electrical Systems” for grounding and bonding requirements.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of cable tray.
   1. Include data indicating dimensions and finishes for each type of cable tray indicated.
B. Shop Drawings: For each type of cable tray.
   1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
   2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to sides of cable trays.
      c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
      d. Load calculations to show dead and live loads as not exceeding manufacturer’s rating for tray and its support elements.
C. Delegated-Design Submittal: For seismic restraints.
   1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
   2. Design Calculations: Calculate requirements for selecting seismic restraints.
   3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Refer to Section 018113 “Sustainable Design Requirements” for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014500 “Quality Control,” to design cable tray supports and seismic bracing.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
   1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAY

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
   1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
   1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
   2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
   3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 WIRE-MESH CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Tube & Conduit; a Tyco International Ltd. Co.
   2. Cablofil
   4. Chatsworth
5. Cooper B-Line, Inc.
7. Mono-Systems, Inc.
8. MP Husky.
9. Niedax-Kleinhuis USA, Inc.
10. TJ Cope.
11. Snaketray.
12. Wiremaid Products Division; Vutec Corporation.
13. WBT, Inc.

B. Description:
2. Width: As indicated on Drawings.
3. Minimum Usable Load Depth: 4 inches (100 mm).
4. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
6. Class Designation: Comply with NEMA VE 1, Class 8C.
7. Splicing Assemblies: Bolted type using serrated flange locknuts.
8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:
1. Steel:
   a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
   b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
   c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
      1) Hardware: Galvanized, ASTM B 633.

2.4 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 WARNING SIGNS

A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.6 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.
PART 3 EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Fasten cable tray supports to building structure and install seismic restraints.

F. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg).

G. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

I. Support cable tray assembly to prevent twisting from eccentric loading.

J. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

K. Support wire-basket cable trays with trapeze hangers or wall brackets.

L. Support trapeze hangers for wire-basket trays with 3/8-inch- (10-mm-) or larger diameter rods.

M. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

O. Make changes in direction and elevation using manufacturer's recommended fittings.

P. Make cable tray connections using manufacturer's recommended fittings.

Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078400 "Firestopping."

R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

S. Install cable trays with enough workspace to permit access for installing cables.

T. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays shall be bonded together with a No. 6 AWG grounding conductor run in the tray along with the communications cables and bonded to each section of cable tray.

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

C. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

D. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.

E. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
   2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
   3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70 and TIA/EIA-569-D. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
   4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
   5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
   6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
   7. Check for improperly sized or installed bonding jumpers.
   8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
   9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all take-off raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.
3.6 PROTECTION

A. Protect installed cable trays and cables.
   1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
   2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
   3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION
SECTION 270536.13
NON-CONTINUOUS CABLE SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the system of non-continuous cable supports as described in this specification.

B. Related Requirements:
   1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories serving communications systems.

1.3 DEFINITIONS
A. UTP: Unshielded twisted pair.
B. ANSI: American National Standards Institute
C. ASTM: American Society for Testing and Materials
D. EIA: Electronic Industries Alliance
E. TIA: Telecommunications Industry Association
F. cULus: Listed by Underwriters Laboratories based on both Canadian and US (United States) standards requirements.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.
   1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

C. Delegated-Design Submittal: For seismic restraints.
   1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
   2. Design Calculations: Calculate requirements for selecting seismic restraints.
   3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.5 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.
1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Refer to Section 018113 “Sustainable Design Requirements” for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

1.6 QUALITY ASSURANCE

A. Non-continuous cable supports and cable support assemblies shall be listed by Underwriters Laboratories for both Canadian and US standards (cULus).

B. Non-continuous cable supports shall have the manufacturers name and part number stamped on the part for identification.

C. Manufacturer: Company specializing in manufacturing products specified in this section with a minimum of five years documented experience in the industry, and certified ISO 9000.


A653 G60-Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-coated (Galvannealed) by the Hot-Dip process.
ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

F. ASTM B117 Standard Method of Salt Spray (Fog) Testing
ASTM D610 Standard test Method for Evaluating Degree of Rusting on Painted Steel Surfaces.

G. ANSI/ TIA/ EIA 568 Commercial Building Telecommunications Cabling Standard, current revision level.

H. ANSI/ TIA/ EIA 569 Telecommunications Pathways and Spaces, current revision level.

I. NFPA 70 National Electrical Code®.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with these specifications, non-continuous cable supports shall be manufactured by Pentair, Inc. or approved equal.

2.2 NON-CONTINUOUS CABLE SUPPORT SYSTEMS

A. Non-continuous cable supports

1. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed.
2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
3. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
4. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
5. Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.

B. Adjustable non-continuous cable support sling

1. Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair UTP; rated for indoor use in non-corrosive environments. Rated to support Category 5 and higher cable, or optical fiber cable; cULus Listed.
2. Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
3. Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.
4. If required, assemble to manufacturer recommended specialty fasteners including beam clips, flange clips, C and Z purlin clips.
5. Acceptable products: Pentair CADDY CableCat™ CAT425; or approved equal.

C. Multi-tiered non-continuous cable support assemblies:

1. Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; cULus Listed.
2. If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips.
3. The multi-tiered support bracket shall consist of Pentair CADDY CATHBA and CableCat™ J-Hooks with screws; or approved equal.
D. Non-continuous cable support assemblies from tee bar
   1. Tee bar support bracket with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
   2. Acceptable products: Pentair CADDY CAT12TS, CAT21528, CAT32528; or approved equal.
E. Non-continuous cable support assemblies from drop wire/ceiling
   1. Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
   2. Acceptable products: Pentair CADDY CAT124Z34, CAT126Z34, CAT214Z34, CAT216Z34, CAT324Z34 or CAT326Z34; or approved equal.
F. Non-continuous cable support assemblies from beam, flange
   1. Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
   2. Acceptable products: Pentair CableCat™ J-Hook series CAT12, CAT21, CAT32, CAT64 with CADDY beam clamps and CADDY flange clips; or approved equal.
G. Non-continuous cable support assemblies from C & Z Purlin
   1. Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed.
   2. Acceptable products: Pentair CableCat™ J-Hook series CAT12, CAT21, CAT32, CAT64 with CADDY Purlin hangers; or approved equal.
H. Non-continuous cable support assemblies from wall, concrete, or joist
   1. Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed.
   2. Acceptable products: Pentair CableCat™ J-Hook series CAT12, CAT21, CAT32, CAT64 with CADDY angle bracket; or approved equal.
I. Non-continuous cable support assemblies from threaded rod
   1. Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, cULus Listed.
   2. The multi-tiered support bracket shall have a static load limit of 300 lbs.
   3. Acceptable products: Pentair CableCat™ J-Hook series CAT12, CAT21, CAT32, CAT64 with CADDY CATHBA series; CAT-CM Double J-Hook CAT100CM, CAT-CM Direct Mount U-Hook, CAT200CMLN, CAT300CMLN; or AFAB Series, or approved equal.
J. Raised floor non-continuous cable support assemblies
   1. Fastener to raised (access) floor pedestal with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments; cULus Listed.
   2. Acceptable products: Pentair CADDY CAT12CD1B, CAT21CD1B or CAT32CD1B; CAT64CD1B; or approved equal.
K. Cantilever-Mounted cable supports
   1. U-hook shall be able to be assembled to a wide variety of wall mounted brackets.
   2. Spacing of individual U-hooks as needed, max of 4’ to 5’ apart.
   3. U-hooks may have the optional attachment of a cable roller for ease in pulling cables.
L. Installation accessories for non-continuous cable supports
   1. Cable Pulley
a. Non-continuous cable supports may be used as an installation tool when a removable pulley assembly is included. The pulley shall be made of plastic and be without sharp edges. The pin and bail assembly must be able to be secured to the J-Hook during cable installation. The pulley must remain secured while cables are being pulled.
b. The pin and roller assembly must be removed after cables are installed.
c. Acceptable products: Pentair CADDY CAT32PLR and CAT64PLR; or approved equal.

2. Cable Protector
   a. The protective steel tube shall fit over threaded rod and be at least 4” in length.
   b. The tube shall prevent damage to cables placed in or pulled through CAT-CM™ U-Hooks.
      The tube shall not inhibit the pulling of cables.
   c. Acceptable products: Pentair CAT-CM™ CATTBCM, or approved equal.

2.3 FINISHES
      ASTM B 695 Standard Specification for coatings of Zinc Mechanically Deposited on Iron and Steel
      ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel
      Products.
      ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-
      Coated by the Hot-Dip Process.
   B. Non-continuous cable supports used where only mildly corrosive conditions apply shall be stainless steel, AISI type 304.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Installation and configuration shall conform to the requirements of the current revision levels of
      ANSI/ EIA/TIA Standards 568 & 569, NFPA 70 (National Electrical Code), applicable local codes,
      and to the manufacturer's installation instructions.
   B. Install cables using techniques, practices, and methods that are consistent with Category 6 or
      higher requirements and that supports Category 6 or higher performance of completed and linked
      signal paths, end to end.
   C. Install cables without damaging conductors, shield, or jacket.
   D. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by
      manufacturer.
   E. Pull cables without exceeding cable manufacturer's recommended pulling tensions. Use pulling
      means that will not damage media.
   F. Do not exceed load ratings specified by manufacturer.
   G. Provide non-continuous cable supports not more than 48” apart.
   H. Adjustable non-continuous support sling shall have a static load limit of 100 lbs.
   I. Unless noted otherwise, provide 4” size non-continuous cable supports.
   J. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078400
      “Firestopping.”
K. Follow manufacturer’s recommendations for allowable fill capacity for each size non-continuous cable support.

1. Non-continuous support having a ¾” loop shall be rated to support up to 16 UTP 4-pair or 2-strand fiber-optic cables.
2. Non-continuous support having a 1-5/16” loop shall be rated to support up to 50 UTP 4-pair or 2-strand fiber-optic cables or one innerduct.
3. Non-continuous support having a 2” loop shall be rated to support up to 80 UTP 4-pair or 2-strand fiber-optic cables.
4. Non-continuous support having a 4” loop shall be rated to support up to 300 UTP 4-pair or 2-strand fiber-optic cables.
5. Adjustable non-continuous cable support sling shall hold up to 425 UTP 4-pair or 2 strand fiber-optic cables.

END OF SECTION
SECTION 270544
SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
      1. Round sleeves.
      2. Rectangular sleeves.
      3. Sleeve seal systems.
      5. Pourable sealants.
      6. Foam sealants.
   B. Related Requirements:
      1. Section 078400 "Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. LEED Submittals:
      1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
      2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
   C. Refer to Section 018113 “Sustainable Design Requirements” for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

PART 2 PRODUCTS

2.1 ROUND SLEEVES
   A. Exterior Wall Sleeves, Cast Iron:
      1. Description: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
   B. Pipe Sleeves, PVC:
      1. Description: ASTM D1785, Schedule 40.
   C. Molded Sleeves, PVC:
      1. Description: With nailing flange for attaching to wooden forms.
D. Molded Sleeves, PE or PP:
   1. Description: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

E. Sheet Metal Sleeves, Galvanized Steel, Round:
   1. Description: Galvanized-steel sheet; thickness not less than 0.0239-inch (0.6-mm); round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

### 2.2 RECTANGULAR SLEEVES

A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:
   1. Description:
      b. Minimum Metal Thickness:
         1) For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness must be 0.052 inch (1.3 mm).
         2) For sleeve cross-section rectangle perimeter not less than 50 inches (1270 mm) or with one or more sides larger than 16 inches (400 mm), thickness must be 0.138 inch (3.5 mm).

B. Sleeves for cables Penetrating Fire rated walls and floors: STI EZ-Path enclosed fire-rated device, containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to adjust, remove, or reinstall firestop materials. The pathway shall be UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).
   1. Series 22 Fire Rated pathway: 1.5 inches (38 mm) high x 1.5 inches (38 mm) wide x 10.5 inches (267 mm) long, volume expansion of fire seal 40 times, inserts into 2 inch (51 mm) cored hole, maintains rating up to 4 hours installed in wall, capacity of approximately 20 CAT5e cables.
   2. Series 33 Fire Rated pathway: 3.0 inches (76 mm) high x 3.0 inches (76 mm) wide x 10.5 inches (267 mm) long, volume expansion of fire seal 16 times, inserts into 4 inch (102 mm) cored hole, maintains rating up to 4 hours installed in wall, capacity of approximately 108 CAT5e cables, up to seven can be ganged together, can be lengthened in 6 inch (152 mm) increments, attaches to a 4 inch (102 mm) conduit, rated for up to 4 hours installed in floor.
   3. Series 44 Fire Rated pathway: 4 inches (102 mm) high x 4 5/8 inches (118 mm) wide x 14 inches (356 mm) long, volume expansion of fire seal 16 times, inserts into 6 inch (153 mm) cored hole, maintains rating up to 4 hours installed in wall, capacity of approximately 255 CAT5e cables, up to five can be ganged together in walls, up to 16 can be ganged together in floors, rated for up to 4 hours installed in floor.

C. Sleeves for Cables Penetrating Non-Fire rated walls: STI EZ-Path enclosed smoke and acoustical pathway, containing a built-in sealing system sufficient to maintain a barrier to prevent smoke and sound from penetrating through non-fire rated walls. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to adjust, remove, or reinstall materials.
   1. Series 33NEZ Smoke and Acoustical Pathway: 4.5 inches (114 mm) high x 4.5 inches (114 mm) wide x 10.5 inches (267 mm) long, and inserts into 4 inch (102 mm) cored hole.
   2. Series 44NEZ Smoke and Acoustical Pathway: 7-1/2” inches (191 mm) high x 7-1/8" inches (181 mm) wide x 10.5 inches (267 mm) long, and inserts into 6 inch (152 mm) cored hole.
2.3 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. CALPICO, Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.
   e. Proco Products, Inc.

2. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.


2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.


2.5 POURABLE SEALANTS

A. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FOAM SEALANTS

A. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
Sleeves and Sleeve Seals for Communications Pathways and Cabling

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE SEAL-SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION
SECTION 274100
AUDIO/VIDEO SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the work specified in this Section.

B. Coordinate work of this Section with work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the work of other Sections.

1.2 SCOPE OF SPECIFICATION

A. The following terms are defined for this specification section:
   1. “Owner” or “End User” is Wayne State University.
   3. “Systems” are the audio and video systems.
   4. “Designer” or “Systems Designer” is the designer of the audio and video systems: Jaffe Holden Acoustics, Inc.
   5. “Electrical Engineer” is the designer of the Electrical Pathway & Wiring Systems: HGA.
   6. “General Contractor” is the General Contractor or Construction Manager responsible for the construction of the project.
   7. “Contractor” or “Systems Contractor” is the specialty contractor working under the General Contractor, responsible for the installation of the audio and video systems.

B. This specification covers all Systems as described below for the project. The objective is to provide professional systems, installed, acceptance tested, and ready for use.

C. General Contractor to provide associated Division 26 scope of work only. Owner to provide all Division 27 scope of work. Refer to Work Scope Table 1.12 below. Read the full specification thoroughly as the Work Scope Table may not include all the details of required scope of work.

D. The written specification and the large format AV drawings shall be collectively referred to herein as the Contract documents. System features which are mentioned in one part may not be shown in the others. In case of conflict between the written specification and the drawings, Contractor must seek clarification from the Systems Designer. In the event that the Contractor fails to obtain such clarification, the interpretation of the Systems Designer will prevail.

1.3 CONTRACTOR RESPONSIBILITY

A. Specification drawings are detailed only to the extent necessary to show design intent and signal flow. It is understood and agreed by the Contractor that the work herein described shall be complete in every detail to supply a complete working system.

B. Equipment not mentioned herein nor shown on drawings but necessary to meet this requirement shall be provided without claim for additional payment.

1.4 SUMMARY DESCRIPTION

A. Appendix A contains the Summary Systems Description. Specific products to meet the system requirements described in Appendix A will be called out in the contract documents. SCOPE OF WORK

A. Furnish all materials, labor and any engineering services to provide complete and professionally installed Systems in working order as described herein. Labor furnished shall be specialized and experienced in Systems installation.
B. Furnish all back boxes and enclosures.

C. Deliver to the job site all back boxes which are to be installed by others.

D. Furnish and install all wire and cable.

E. Contractor to provide initial DSP and control system programming prior to acceptance testing, one full set of programming changes and adjustments, prior to handover to the Owner, and one additional set of changes and adjustments during the initial warranty period, as part of the base scope of work.

F. Furnish any additional items, not specifically mentioned herein, to meet system requirements as specified, without claim for additional payment. Such items may include, but are not limited to hardware, transformers, signal format converters, line/distribution amplifiers and other devices for proper installation, interface, isolation or gain structure.

G. Furnish shop drawings and receive approval, prior to fabrication and installation.

H. Provide frequency scanning and coordination for all audio/video systems wireless transmitters and receivers. Coordinate with other Contractors and Owner as necessary to account for local frequencies used by others within the building, and to account for available spectrum in the surrounding area.

I. Perform initial adjustments and verification tests. Submit verification test report.

J. Participate in acceptance tests and perform final adjustments.

K. Provide training sessions, as specified in section 3.15, to the Owner.

L. Provide any manufacturer required commissioning and/or training and properly schedule with the manufacturer for their staff to attend. Coordinate schedule and training syllabus with owner and consultant.

M. Provide system documentation including copies of all relevant drawings and equipment manuals.

N. Provide maintenance services for the specified period from the date of acceptance.

O. Guarantee all equipment and components for the specified period from the date of acceptance.

P. Requirements and materials that apply to the work of others related to the Systems are listed to define and establish Systems requirements.

Q. Work scope does not include the AC power system except as specifically called out in these specifications or in the drawings.

R. Coordination with the Electrical Contractor is required to assure correct Systems conduit routing, Systems backbox locations, and clean power circuit locations as specified in Division 26 - Electrical.

S. See Work Scope Summary Table at the end of Part One (Paragraph 1.12).

1.6 SUBMITTALS

A. Pre-Bid Submittals
   1. All Contractors submitting bids for the Systems specified herein must be qualified by the Systems Designer.
   2. Not later than ten (10) days prior to the bid date, Contractor shall submit to the Systems Designer for approval, brochures containing a statement of the Contractor's qualifications. At minimum, this submittal shall include the following:
      a. A list of Systems of comparable size and scope to that described herein, completed by the Contractor in the last five (5) years. Indicate the project name
and address, year of completion, and the name and phone number of a person to contact who is a representative of the Owner or User.

b. A personal resume of formal education and experience, and a copy of the current CTS-I certificate of the staff member who would act as Leader for the Project. A personal resume of formal education and experience, and a copy of the current CTS-D certificate of the staff member who would act as Project Engineer.

c. A description of the Contractor's capabilities and facilities for rack assembly, shop fabrication, repair, and servicing of Systems.

d. A description of the Contractor's capabilities and facilities for generating CAD (or other high quality graphics) documentation for the Shop Drawings and As-Built Drawings.

B. Bid Submittals:

1. Contractors shall examine all drawings and read all divisions of this specification in order to avoid omissions and duplications and to ensure a complete job. No allowances shall be made for failure to read and understand these documents. Discrepancies between drawings and specifications or obvious omissions shall be referred to the Systems Designer for clarification before the bid date. Where discrepancies occur and pre-bid instructions have not been obtained, the contractor agrees to abide by the Systems Designer's decision.

2. Bid proposals shall include all work and all equipment as specified, as well as any other equipment and materials to be used in assembling the system.

3. Requests for clarification of specification intent shall be made, in writing, not later than ten (10) days prior to bid date.

4. No portion of the work herein may be assigned or sub-contracted to others unless the following requirements have been satisfied:
   
a. The names of any proposed sub-contractors shall have been disclosed in the bid proposal.
   
b. A statement of qualifications for each sub-contractor shall have been included with the bid proposal.
   
c. All terms of this contract, including bidding and qualification requirements, shall apply to the sub-contractor.

5. The bid submittals shall include the following:
   
a. The total Contract price
   
b. The total price for any Add-Alternates (See Paragraph 2.02.D)
   
c. An itemized list of all equipment and materials to be used in assembling the system
   
d. Unit pricing for all items on the specified equipment list
   
e. Lot pricing for miscellaneous items not on the specified equipment list
   
f. A breakdown of the number of staff hours allotted for:
      
      1) Preparation of submittals, shop drawings, and system documentation
      2) On site coordination meetings and supervision
      3) In shop engineering, fabrication, and assembly
      4) On site fabrication, assembly, and installation
      5) On site verification and acceptance testing

C. Shop Drawing Submittals:

1. Within thirty (30) days after contract award, submit a Work Scope plan that lists all actions required to complete the work in this section. The Work Scope plan must include a complete schedule of all activities, particularly activities that require coordination with other trades, Architect, Owner, and Systems Designer, and must reference all relevant documents related to each activity. Critical path must be identified, and all key moments relating to procurement and installation must be identified. All points of coordination must be vetted with the other affected parties prior to submittal to the Owner for review.
2. Within sixty (60) days after contract award, submit digital PDF files of detailed shop drawings to the Architect for approval. All shop drawings shall be marked with the related drawing number when submitted. Do not begin installation or fabrication without the approval of the Architect and Systems Designer.

3. Review of shop drawings shall not constitute final approval of system function. Said review does not in any way relieve the Contractor from the responsibility of furnishing material or performing work as required by the Contract documents.

4. Failure of the Contractor to submit shop drawings in ample time for evaluation shall not entitle the Contractor to an extension of contract time, and no claim for extension by reason of such default will be allowed.

5. Systems Designer will review submittals twice only without additional cost being charged to the project. If a submittal or portion of a submittal is rejected after two attempts, the Contractor is liable for additional cost for further reviews.

6. At minimum, the Shop Drawings shall include electronically bound copies of the following:
   a. Table of Contents
   b. Itemized list of all equipment and materials to be used in assembling the system
   c. Catalog cut sheets or data sheets for each listed item.
      1) Product data sheets must not be web page captures of specifications, unless there is no other recourse.
      2) Product data sheets with multiple options or part numbers must clearly be marked with the selection to be used for this project. All options must be called out. Anything the Contractor is not supplying that is shown on the sheet must be called out as an exclusion.
   d. One-line signal flow diagrams for all systems showing point to point wiring interconnection of all equipment with wire run numbers and patch bay designations. Show all transformers, switches, relays, control circuits, and modifications to equipment. Show all equipment items which are required for realization of the functions described herein.
   e. A complete list of all wire run numbers along with the termination location of each end of each wire run
   f. Detailed 3-wire schematic diagrams for any custom circuitry
   g. Detailed 3-wire schematic diagrams for typical connections between audio lines, patch bays, and rack mounted equipment
   h. Drawings of all items which are to be custom fabricated or modified. Drawings shall be of scale suitable for use in fabrication. They shall show materials, finishes and panel/control markings. Submit samples of lettering/label size and typeface to be employed on custom plates, panels and other equipment.
   i. Full size drawings illustrating the physical layout and labeling of patch bays
   j. Mechanical drawings of all assemblies, major sub-assemblies, racks, and enclosures
   k. Mechanical drawings showing proposed mounting details of all loudspeakers and associated rigging, and interface with adjacent architecture
   l. All mounting systems not provided as a complete package from a single manufacturer must be engineered, approved, and have drawings stamped by a professional rigging engineer or licensed structural engineer, as approved by the General Contractor. The engineer shall verify that the design meets or exceeds design criteria for this particular use case. Each mounting system solution must be separately engineered, verified, and stamped.
   m. Provide a detailed written plan for EDID and HDCP management for all video signals and interconnections between video devices.
   n. Provide an IP Address table and addressing protocol in coordination with Owner’s IT department.
   o. Provide a mockup of all system graphical user interface screens and all source code/configuration files required for proper system operation.

7. For the ease of drawing review, the following guidelines must be adhered to:
a. Plot styles should be utilized so that color is only used for emphasis of specific line types.
b. The paper size for all shop drawings must match that of all other construction drawings. All drawings must be legible at ½ size.
c. Drawings should be in black and white but if color is used the drawings must still be legible with all design information easily seen, when printed black and white.
d. CAD drawings should be delivered as PDF prints. Provide DWG files upon request.
e. All revisions of drawings in drawing packages must include a revision number and date, with all changed drawings clearly indicated, with changes clouded and tagged with the revision number. Drawings that have not changed from previous releases should not be marked as revised. Already revised drawings should have revision clouds and tags removed from the previous revision so that current revisions are clear to see.

8. Document release must be simultaneous unless a tiered release is authorized by the Systems Designer. If utilizing a tiered document release system, each release must be a full release of documents within each tier, within the context of the entirety of this scope of work. The required order for tiered review is:
   a. Equipment and Panel Locations, and Conduit Riser (provided as indicated in the Work Scope Table in this section)
   b. Complete project equipment list and Product data sheets
   c. Single-line drawings, Panel details, Rack elevations, and Patchbay layouts
      1) Patchbay layouts must conform to the guidelines for Patchbay layouts included in this specification and on large format drawings.
      2) Panel drawings must indicate each panel and its engraving individually (if two ‘AA’ panels exist, for instance, they must have individual panel drawings showing the connector numbering and other engraving specific to that panel at that location)
      3) All custom rack panels must have a panel drawing as part of this submittal.
   d. Rigging and Mounting Details
   e. Control system and DSP system GUI mockup, functional control narrative, initial DSP programming, other software configuration files, HDCP/EDID plan and IP addressing plan.

9. All drawings shall be produced in AutoCAD, Revit, or in a similar and compatible computer drafting/graphics program. All submittal drawings must be engineered and drafted to represent actual fabrication and installation drawings and details. All details that are graphically unclear must be properly noted to clarify intent. Copies of the Contract Drawings are not acceptable as submittal drawings and will be rejected.

10. The use of electronic files generated by anyone other than the Systems Contractor (e.g., architectural backgrounds, Systems Designer's drawings, etc.) will not release the Contractor of the responsibility to supply Shop Drawings that represent a completely engineered, coordinated, and functional solution. The Contractor has the final responsibility to provide systems that meet or exceed all requirements of the contract documents.

D. Substitutions:
   1. Substitutions may be permitted subsequent to Contract award, but only with the express written permission of the Systems Designer. The proposed substitutes must be equivalent to the specified products in quality, performance, construction, function and conformance to system objectives.
   2. It is the responsibility of the Contractor to prove, to the satisfaction of the Systems Designer, that the proposed substitution is equal to the specified product, as demonstrated by submission of the following:
      a. List of advantages to the Owner
      b. Cost savings
c. Printed specifications or laboratory test data
d. Previous field experience
3. The Contractor shall list the unit price of each item proposed for substitution and indicate which specified items are to be deleted.
4. If the Systems Designer determines that the proposed product is not equal to the specified project, the Contractor shall supply the product specified in the Contract documents.
5. Where substitute materials or methods are approved, the Contractor shall make all adjustments to contingent work necessary to accommodate the substituted equipment, without claim for additional payment.
6. In the event that one or more of the products specified herein is unavailable, the Contractor shall make recommendations to the Systems Designer as to what substitutions are available to meet the intent of the specification.
7. The Systems Designer reserves the right to substitute new products which become available subsequent to the issuance of the Contract Documents, provided that:
a. The Contractor has not yet purchased the originally specified equipment.
b. The substitute equipment shall not materially increase the Contractor's costs.
8. Selected items of the systems are subject to rapid technology changes. Items that have a high likelihood of needing re-evaluation prior to installation are highlighted in the equipment list. The Contractor shall not purchase these items without 30 days prior notice to the Systems Designer.

E. Samples:
1. Submit samples of substitute equipment to the Systems Designer as required to prove equivalency to items specified.
2. Submit samples of custom work, finishes or other materials as required by the Architect or Systems Designer to verify appearance and quality. All panels within direct view of the public may require a custom finish. Provide the Architect with a list of any panels that meet this criteria so that they may specify custom finishes. A sample of every type of finish specified other than standard finish as detailed in this specification must be provided to the Architect for approval.
3. Costs for shipping samples shall be the responsibility of the Contractor.
4. Submitted samples will not be returned.

F. Progress Reports must be submitted to the Owner every two weeks. The progress report will include:
1. Work Scope Plan updates and any schedule changes
2. Overall Project Status
3. Work Completed by percentage complete
4. Work planned for the next two week period
   a. Call out any coordination requirements for each item.
5. Procurement report
   a. Percentage by dollar value of equipment that has been procured to date
   b. Procurement problems or concerns to be addressed by others
6. RFI/Submittal List
   a. List outstanding RFI's and Submittals, showing the assigned document number and the date it was submitted.
   b. Highlight in Yellow any items that are overdue but are not affecting schedule or project quality.
   c. Highlight in red any items that are overdue AND are affecting schedule and/or project quality.

G. Written Guarantee (See Paragraph 1.9)
H. Verification Test Report (See Paragraph 3.13)
I. System Documentation and Operation Manuals (See Paragraph 3.15)
1.7 JOB CONDITIONS

A. Keep the job adequately staffed at all times. Unless illness, loss of personnel or other circumstances beyond the control of the Contractor intervene, keep the same individual in charge throughout.

B. Cooperate with all appropriate parties in order to achieve well-coordinated progress with the overall construction completion schedule and satisfactory final results.

C. Watch for conflicts with work of other contractors on the job and execute, without claim for extra payment, moderate moves or changes as are necessary to accommodate other equipment or to preserve acoustic performance, symmetry, and pleasing appearance.

D. Immediately report to the Architect and Systems Designer any design or installation irregularities, particularly architectural elements that interfere with the intended coverage angles of loudspeakers, or proper open sightlines to projection surfaces or displays so that appropriate action may be taken.

E. Do all cutting, patching and painting for proper and finished installation of the system and repair any damage done as a result of such installation. Clean up and dispose of trash from all Systems work areas.

1.8 QUALITY ASSURANCE

A. Parts listed shall be complete, type numbers accurate and equipment furnished shall conform to manufacturer’s specifications.

B. All materials shall be new and shall conform to applicable provisions of Underwriters Laboratories and the American Standards Association.

C. Procure and pay for all permits, licenses and inspections and observe any requirements stipulated therein.

D. Comply with federal, state and local labor regulations and applicable union regulations.

E. Installation shall conform to latest federal, state and local electrical and safety codes or those of other authorities having jurisdiction. Where conflicts exist, the most stringent code or regulation shall apply.

F. If additional work by the Systems Designer is required as a direct result of deviations from approved drawings and specifications during construction, the General Contractor and/or Systems Contractor will be liable for those additional costs that the Owner may incur.

G. Government Standards: The Systems Contractor is to comply with all government regulations, standards, and laws that apply to the installation and use of the AV equipment and/or other scope of work specified in this section. The following agencies have laws and rules that apply.

1. Federal Communications Commission (FCC): FCC rules are located in Title 47 of the Code of Federal Regulations. The following is a partial list of the FCC regulations that apply to equipment specified in this section of work:
   a. Part 15: Radio frequency devices
   c. Part 24: Personal communications services.
   e. Part 27: Wireless communications service.
   f. Part 51: Interconnection.
   g. Part 74: Experimental radio, special broadcast, and other program distribution services.
   h. Part 95: Personal radio services.
2. Occupational Safety and Health Administration (OSHA) – Follow all applicable standards for health and safety particularly sound pressure level exposure.

3. ANSI Standards: American National Standards Institute (ANSI) standards cover safety, fabrication, assembly, installation, rigging, equipment handling, and testing.

4. Contributing Organizations – The Organizations listed below have published standards used to establish the technical references to be followed under this scope of work.
   a. Acoustical Society of America (ASA) (ASC S1)
   b. Alliance for Telecommunications Industry (ATIS) (ASC T1)
   c. American Society of Safety Engineers (ASSE) (ASC A1264)
   d. Audio Engineering Society (AES) (ASC S4)
   e. Electronics Industry Alliance (EIA) (CEMA)
   f. Entertainment Services and Technology Association (ESTA) (ASC E1)
   g. Institute of Electrical and Electronics Engineers (IEEE) (ASC C136) (802.1)

1) IEEE 802.1AS: This standard specifies the protocol and procedures used to ensure that the synchronization requirements are met for time sensitive applications, such as audio and video, across Bridged and Virtual Bridged Local Area Networks consisting of LAN media where the transmission delays are fixed and symmetrical.

2) IEEE 802.1QAT: This standard specifies protocols, procedures and managed objects, usable by existing higher layer mechanisms, that allow network resources to be reserved for specific traffic streams traversing a bridged local area network. It identifies traffic streams to a level sufficient for bridges to determine the required resources and provides a mechanism for dynamic maintenance of those resources.

3) IEEE 802.1QAV: This standard allows bridges to provide guarantees for time-sensitive (i.e. bounded latency and delivery variation), loss-sensitive real-time audio video (AV) data transmission (AV traffic). It specifies per priority ingress metering, priority regeneration, and timing-aware queue draining algorithms. This standard uses the timing derived from IEEE 802.1AS. Virtual Local Area Network (VLAN) tag encoded priority values are allocated, in aggregate, to segregate frames among controlled and non-controlled queues, allowing simultaneous support of both AV traffic and other bridged traffic over and between wired and wireless Local Area Networks (LANs). Bridges are increasingly used to interconnect devices that support audio and video streaming application. This standard will specify enhancements to bridge relay function to provide performance guarantees to allow for time-sensitive traffic in a local area network and harmonize delay jitter and packet loss for wired (e.g., IEEE 802.3 - "Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications"), wireless (e.g., IEEE Std 802.11 - "Standard for Information Technology - Telecommunications and information exchange between systems - Local and Metropolitan networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications"), and mixed wired/wireless L2 networks. Most if not all entertainment media going forward is in digital form. Audio and video streaming and interactive applications over bridged LANs need to be enhanced to have comparable real-time performance of legacy out-of-band analog media distribution. There is significant vendor and end-user interest and market opportunity to consolidate layer 2 solution for both computer networking (e.g. internet access) and audio video services (e.g. home consumer electronics, professional A/V applications, etc) in mixed wired and wireless environments. The use of such consolidated network will realize operational and equipment cost benefits.
This standard defines a set of enhancements to the Virtual Bridged LAN (802.1Q - “Standards for Local and Metropolitan Area Networks - Virtual Bridged Local Area Networks”). This will enable end-to-end quality of service guarantee agreement for audio and video streaming negotiated over SRP protocol to be realized in a bridged LAN, while interoperating with existing 802.1D - "Standard for Local and Metropolitan Area Networks: Media Access Control (MAC) Bridges” and Q bridges. There is currently no interoperability among bridges that support Audio and Video streaming, nor generally accepted means of achieving such service guarantees in a bridged LAN.

4) IEEE 802.3 – 2008: A revision of base standard incorporating the 802.3an/ap/aq/as amendments, two corrigenda and errata. Link aggregation was moved to 802.1AX.

5) IEEE 802.3AZ: Energy Efficient Ethernet is scheduled for release in September 2010.

6) IEEE 802.3bd: Defines a MAC Control Frame to support 802.1Qbb Priority-based Flow Control.

h. International Cable Engineers Association (ICEA) Formerly IPCEA
i. International Standards Organization (ISO)
j. National Electrical Manufacturer’s Association (NEMA) (ASC C119)
k. National Fire Protection Associations (NFPA)
l. National Safety Council (NSC) (ASC A10)
m. Photographic and Imaging Manufacturer’s Association (PIMA)
n. Society of Motion Picture and Television Engineers (SMPTE)
o. Telecommunications Industry Association (TIA)
p. Underwriters Laboratories (UL) (ASC C101) (CE)
q. NTSC
r. National Association of Broadcasters (NAB) – System technical standards for video and RF compliance are listed in the most recent edition of the NAB Handbook

5. Safety Standards – Contractor will adhere to the following Safety Standards for all work identified in Division 27 41 00 and as part of the General and Supplementary sections of the Division-1 Specifications.

a. ANSI A14.2-2000: Safety Requirements for Portable Metal Ladders

e. ANSI Z136.2-1997: Safe Use of Optical Fiber
g. ANSI/PIMA IT7.101-1999: Recommended Practice for the Safe Handling and Operating of Audiovisual Equipment.

h. IEEE 142-1991: Grounding of Industrial and Commercial Power Systems
i. UL 514A: Scrub Water exclusion from AV Floor Boxes
j. UL 1419-1995: Standard for Safety for Professional Video and Audio Equipment in accordance with the National Electrical Code, ANSI/NFPA 70
k. UL 1492-1994: Standard for Safety for Audio-Video Products and Accessories
l. UL 1651-1997: Standard for Safety for single and multiple Optical Fiber Cable

m. UL 1667-1996: Audiovisual Systems Safety Standard for Tall AV Institutional Carts for use with Audio, Video, etc.

n. ANSI E1.1-1999: Construction and Use of Wire Rope Ladders to prevent most injuries
o. ANSI A10.8-2001: Safety Requirements for Scaffolding
6. Applicable Performance Standards – Execute all Division work in accordance with the following standards:
   b. ANSI S4.55-1997: Recommended Practice for conservation of the Polarity of Audio Signals
   c. ANSI S4.56-1997: Recommended Practice for the subjective evaluation of Loudspeakers
   f. ANSI T1.522-2000: Quality of Service (QOS) for Business Multimedia Conferencing. Specifies classes of Service for conferencing on IP Networks
   g. AES15: ANSI S4.49: AES Recommended practice for Sound Reinforcement Systems – Communications Interface PA-422.
   h. AES-R1-1997 AES project report for professional audio: Specifications for audio on high capacity media
   i. AES14-1992 (r1998) AES standard for professional audio equipment -- Application of connectors, part 1, XLR-type polarity and gender
   j. AES24-1-1999. (Revision of AES24-1-1995) AES standard for sound system control - Application protocol for controlling and monitoring audio devices via digital data networks
   k. AES26-2001 (Revision of AES26-1995) AES recommended practice for professional audio -- Conservation of the polarity of audio signals
   l. ANSI/TIA/EIA 606-1993: Standard for the Telecommunications Infrastructure of Commercial Buildings
   m. ANSI/TIA/EIA 607-1994: Commercial Building Grounding and Bonding Requirements for Telecommunications
   n. IEEE 149-1979 (R1990): Test Procedure for Antennas
   o. IEEE 1100-1999: Powering and Grounding Sensitive Electronic Equipment
   p. NEMA 250-2001: Enclosures for Electrical Equipment
   q. SMPTE 292M: SMPTE 292M defines the base 1.485Gbps HD-SDI. Note: This standard can handle all HD formats except 1920*1080 @ 50P and 60P.
   r. SMPTE 372M: Uncompressed Dual-Link HD-SDI for 50P & 60P
   s. SMPTE 424M: 2.97 Gbps HD-SDI for 50P & 60P
   t. TIA/EIA-568-B: Digital audio over Cat5 audio cable
   u. UL 1047-1999: Isolated Power Systems Equipment
   v. UL 1581-1998: Reference Standard for Electrical Wires, Cables, and Flexible Cords
   w. UL 1682-1998: Standard for Safety for Plugs, Receptacles, and Cable Connectors, of the Pin and Sleeve Type up to 800 Amperes and up to 600 volts ac or dc.
   x. UL 467-1998: Grounding and Bonding Equipment
   y. UL 813-1999: Commercial Audio Equipment and accessories for use in commercial enterprises… this standard was originally listed for public review in the October 13, 1995 issue of Standards Action. It is being resubmitted owing to substantive changes in the text.
   z. ANSI/TIA/EIA-568-A: Commercial Building Telecommunications Cabling
   aa. ANSI/TIA/EIA-569-A: Commercial Building Standard for Telecommunications Pathways and Spaces
   bb. ANSI/TIA/EIA-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
   cc. ANSI/TIA/EIA TSB-72: Centralized Optical Fiber Cabling Guidelines
   dd. ANSI/TIA/EIA-526-14A: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
1.9 GUARANTEE AND SERVICE

A. All systems and components shall be guaranteed free of defects in materials and workmanship for a period of one (1) year (or to the length of the Manufacturer’s warranty if longer) from the date of acceptance and shall be repaired or replaced within forty-eight (48) hours following report of such defects by the owner.

B. The Contractor shall be available on call and on eight (8) hour notice during the first month following acceptance of the system, to assist the Owner’s representatives in any problems which may arise during the initial period of operation. If corrective measures on-site are required they will be performed within 12 hours of the determination of a need for a site visit.

C. If, during the Guarantee period, any component is out of service for more than seven (7) days due to unavailability of parts or service, Contractor shall supply and install an identical new component. If an identical component is not available, Contractor will substitute equivalent equipment, with the approval of the Owner.

D. During the course of the Guarantee period, the Systems Contractor will provide the Owner with a 24 hour service phone number for emergency calls. A service engineer will respond to all emergency calls within one (1) hour. The personnel answering this call must be fully qualified to troubleshoot problems and propose solutions. A qualifying emergency event is defined as an event that may cause severe hardship or cause the systems to be inoperable or unusable for a scheduled class or event.

E. During the course of the Guarantee period, the Contractor shall provide a minimum of three (3) service visits to the site for inspection and adjustment of equipment. Contractor shall submit proposed schedule for these visits and shall notify Owner and Systems Designer in writing at least one month in advance of each visit.

F. During the course of the guarantee period, the Systems Contractor will supply the Owner with any published updates of manufacturer provided operating programs for any and all software-controlled equipment that are issued to correct “bugs”. During the Guarantee period, the Owner will rely on the Systems Contractor to determine when to update the software, unless it is needed to correct a situation that renders the systems unstable, non-functional, or otherwise affects operations.

G. Repeated device failures, defined as the failure of a device or a single type of device three or more times over three contiguous months, will be considered as a failure of a manufactured system and all items of this type shall be replaced at no charge to the Owner.

H. At least one representative of the Systems Contractor, well versed in the installation and the operation of the systems, shall be on site in support of the Owner for the first significant public event in each space (as determined by the Owner) where the system will be used. The Contractor representative(s) for this event shall also be competent in show operations.

I. Contractor is to coordinate ongoing remote access to AV Systems Networks for support and troubleshooting. Owner to provide the access at their discretion.

1.10 INSURANCE

A. All equipment and materials shall be fully insured against loss or damage up until acceptance of the system by the Owner or until Owner relieves the Contractor in writing of this responsibility, whichever is earlier, regardless of the location of the equipment. All equipment is
deemed to be under the control of the Systems Contractor until acceptance of the system by the Owner or until Owner relieves the Contractor in writing of this responsibility, whichever is earlier.

1.11 EXISTING CONDITIONS

A. Visit the site prior to making a bid. No subsequent allowance will be made due to failure to thus observe and verify conditions which may affect the work. Report to the Architect and Systems Designer any discrepancies among this specification and existing conditions and similarly report obvious omissions.
### 1.12 WORK SCOPE SUMMARY TABLE

<table>
<thead>
<tr>
<th>ITEMS TO BE PROVIDED AND INSTALLED</th>
<th>General Contractor</th>
<th>Electrical Contractor</th>
<th>Systems Contractor</th>
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<tr>
<td>x Provide Install x Install x Provide Install x Install x</td>
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<tr>
<td>Main Power Service Panel Boards and Circuit Breakers</td>
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<td>• Main Power Service Conduit and Conductors</td>
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<tr>
<td>• Main Power Service Terminations</td>
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<tr>
<td>Audio &amp; Video Technical Power (AVTP) Transformers</td>
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<tr>
<td>• Transformer Conduit and Conductors</td>
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<tr>
<td>• Transformer Terminations</td>
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<tr>
<td>AVTP Isolated Ground Conduit and Conductors</td>
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<td>• Isolated Ground Terminations</td>
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<tr>
<td>AVTP Distribution Panelboards and Circuit Breakers</td>
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<td>• Distribution Panelboard Conduit and Conductors</td>
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<td>• Distribution Panelboard Terminations</td>
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<td>AVTP Standard Load Centers and Circuit Breakers</td>
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<td>• Standard Load Center Conduit and Conductors</td>
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<td>• Standard Load Center Terminations</td>
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<tr>
<td>AVTP Company Switches for Portable Equipment</td>
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<td>• Company Switch Conduit and Conductors</td>
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<td>• Company Switch Terminations</td>
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<tr>
<td>AVTP Outlet Devices for Branch Circuits delivered to Systems Equipment Racks and Devices</td>
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<tr>
<td>• Equipment Rack Back Boxes and Wall Plates</td>
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<td>• Outlet Device Back Boxes</td>
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<td>• Outlet Device Wall Plates</td>
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<td>• Branch Circuit Conduit and Conductors</td>
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<td>• Branch Circuit Termination</td>
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<td>Systems Equipment Racks and Devices</td>
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<td>• Metallic Conduit between Systems Devices and Racks</td>
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<td>• Insulation Bushings between Metallic Conduit Racks</td>
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<td>• Systems Equipment Rack Cabling</td>
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<td>Systems Device Back Boxes and Floor Boxes</td>
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<td>- Systems Device Metallic Conduit</td>
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<tr>
<td>- Systems Device Cabling</td>
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<tr>
<td>- Systems Device Connection Plates and devices</td>
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<tr>
<td>- Systems Device Termination</td>
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<tr>
<td>Empty Conduit (for temporary use)</td>
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<tr>
<td>- Systems Cable Trays</td>
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<td>- Systems Cable Sleeves</td>
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<tr>
<td>- Systems Pull Boxes</td>
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<tr>
<td>Conduit Riser Diagram Submittal</td>
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<tr>
<td>Structural Support for rigging and devices provided by Systems Contractor</td>
<td>x◊</td>
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</tbody>
</table>

◊ Installation criteria to be provided by Systems Contractor
PART 2 EQUIPMENT

2.1 GENERAL EQUIPMENT

A. Whenever any equipment is specified by manufacturer and model number, it is for purposes of establishing a standard of quality, performance, construction and function.

B. All materials and equipment shall be new and of the latest design or model offered for sale by the manufacturer.

C. Equipment models provided shall operate at the required AC line voltage and frequency.

D. Contractor shall provide quantities as indicated in the equipment list, detail drawings, location drawings, schedule of terminations, and as required for a complete installation.

E. Audio & Video Wire and Cable
   1. All wire numbers listed in the drawings are Belden unless otherwise noted.
   2. THHN wire is not an allowable substitute for twisted pair stranded loudspeaker wiring.
   3. Approved manufacturers: Belden, Canare, Gepco, West Penn, Whirlwind
   4. Where conflict exists with any codes or ordinances, such codes and ordinances shall take precedence.
   5. Where conflict exists with electrical specifications, the higher standard or more stringent requirement shall apply.

F. Wiring Devices
   1. Duplex Receptacles: per electrical drawings
   2. AV Technical power plates for receptacles must be labeled with the panel number and breaker number for the circuit(s) they are connected to (to be provided and installed by DIV. 26)

G. AV System Plates and Panels:
   1. Specifications – Rack Mount Panels
      Material: 11 gauge steel or 1/8" Aluminum, minimum thickness
      Finish: Black or to match adjacent equipment
      Size: 19" wide, standard EIA mounting hole spacing, height as specified
   2. Specifications – Back Box Enclosures
      Material: Code grade steel
      Finish: Black or galvanized
      Size: As specified
   3. Specifications – Plug Box and Termination Panels
      Material: 11 gauge steel or 1/8" Aluminum, minimum thickness
      Finish: Black (unless instructed otherwise by Architect)
      Size: As specified
   4. Approved Manufacturers: Steel City, Raco, Hoffman, Whirlwind, Pro Co, Wireworks

H. Audio Transformers
   1. All transformers shall be selected for proper interface and loading in the circuits as required by as-built conditions and per manufacturer's recommendations.

2.2 MAJOR EQUIPMENT

A. Equipment provided shall be that specified herein or approved substitute (see Paragraph 1.6.B).

B. Detailed performance specifications shall be those published by the manufacturer effective on the date of this document for all equipment listed.

C. See spreadsheet of major equipment in Appendix B.
2.3 DETAIL DRAWINGS

A. The drawings herein may detail custom built equipment and system details.

B. Furnish all materials and labor to provide complete and finished work even though not specifically shown on the drawings.

C. Detail drawings are located in large format AV drawings.
PART 3 EXECUTION

3.1 AUDIO SYSTEM REQUIREMENTS

A. Requirements herein refer to materials and work which are related to or part of the Systems. Where conflict exists with other specifications concerning such work or materials, this specification takes precedence unless otherwise approved in writing by the Owner.

3.2 INSTALLATION OF SYSTEMS

A. Locate all apparatus requiring adjustments, cleaning or similar attention so that it will be accessible for such attention. Equipment racks shall be positioned to permit full access for operation and service.

B. Furnish and install brackets, braces and supports. All mounting hardware shall be included.

C. All bolts and fasteners must be Grade 5 or better.

D. All bolted attachments to have lock washers or other self-locking fasteners.

E. Provide all required mounting brackets and framing, hardware and components, safety systems and rigging systems using the following minimum design factors (given as ratio of working load limit (WWL) : rated breaking load):

1. 5:1 – Minimum design factor for all mounting components regardless of mounting condition.

2. 5:1-8:1 – Minimum design factor for manufacturer provided mounts & assemblies where engineered stamped documentation and destructive testing data is provided by manufacturer.

3. 10:1 – For all hardware and connecting assemblies between manufacturer rated assemblies when equipment is hung above the general public. This includes but is not limited to wire rope, bolts, shackles, turnbuckles, beam clamps, supplemental steel provided by Systems contractor and other connecting hardware.

4. Design factor calculations to be provided with all equipment mounting details.

5. Systems Contractor shall coordinate required additional blocking, supplemental steel or channel strut supports with Main Contractor & specific trade contractors.

6. All mounting systems not provided as a complete package from a single manufacturer must be engineered, approved, and have drawings stamped by a professional rigging engineer or licensed structural engineer, as approved by the Main Contractor. The engineer shall verify that the design meets or exceeds design criteria for this particular use case. Each mounting system solution must be separately engineered, verified, and stamped.

F. All supporting structures and enclosures supplied by the Contractor not having a standard factory paint finish shall be painted. Paint specifications will be supplied by the Architect or indicated herein.

G. Provide custom color or finish for any equipment or materials supplied which are exposed to public view. Color and finish of all such equipment or materials shall be approved in writing by the Architect. This does not exclude equipment or materials where standard colors and finishes may be specified herein.

H. Finish of blank panels and custom assembly panels shall match adjacent equipment panels. Verify all panel colors with Architect. All color choices should be clearly indicated on panel drawing submittals, and on the panel schedule.

I. Switches, connectors, jacks, receptacles, outlets, cables and cable terminations shall be logically and permanently marked. Custom panel nomenclature shall be engraved, etched or screened. Markings for these items are detailed in the drawings to ensure consistency and clarity. Verify any changes in working type size and/or placement with the Systems Designer prior to marking.
J. Protect equipment and related wiring where construction conditions may cause damage or environmental conditions exceed manufacturer’s specifications.

K. The standard reference for the layout and construction of the system shall be:

3.3 CONDUIT

A. Review and coordinate Systems conduit installation with the electrical contractor to ensure proper operation of the Systems.

B. All wiring shall be in conduit unless authorized by the Architect, approved by the Systems Designer, and permitted by code. Exceptions are short runs at rack terminations where there is no means of connecting conduit to the equipment.

C. Where installed exposed, conduits shall be parallel with or at right angles to walls or ceilings and shall be supported from walls or ceilings by means of approved galvanized iron clamps or hangers. Conduit connections to equipment racks shall be insulated.

D. Minimum size conduit shall be 3/4 inch. All conduit shall be sized for maximum 40% fill or less if required by code.

E. No conduit run between pull boxes/termination boxes may exceed 100 feet in length.

F. No conduit run shall have more than 180 degrees of combined turns between pull boxes/termination boxes, and no single turn may exceed 90 degrees.

G. Conduit containing STP, UTP, and COAX wire types must be installed so that the final length of the cable runs does not exceed maximum cable lengths as stated in 3.8.N and 3.8.O.

H. All conduits, within 6” of termination box, junction box, gutter or rack/ladder tray, must be labeled with conduit group and destination of the opposite end of that conduit, as follows: “AV - <Group> - <opposite end>”. For example “AV – B – AA stage right”. Permanent marker on the conduit where it can be seen from the ground or nearest access point is acceptable.

3.4 CONDUIT SEPARATION

A. Systems wiring is divided into wiring groups according to their nominal voltage levels (refer to Schedule of Terminations):

<table>
<thead>
<tr>
<th>Wiring Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
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<tr>
<td>Group B</td>
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<tr>
<td>Group C</td>
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<tr>
<td>Group D</td>
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<tr>
<td>Group E</td>
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<tr>
<td>Group F</td>
</tr>
</tbody>
</table>

Note: These wiring groups must never be intermixed within a given conduit run or junction box.

B. Minimum conduit separation between conduits carrying wiring of different groups is:

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
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<tr>
<td>Group A</td>
<td>adjacent</td>
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<td>Group C</td>
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<td>Group F</td>
<td>12&quot;</td>
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Note: Ninety degree crossings in close proximity are acceptable. Separations must be maintained until within six feet of box or gutter entry.

C. Minimum conduit separation between conduits carrying Systems wiring and other electrical service conduit is:

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<tr>
<td>Dimmer controlled lighting</td>
<td>24&quot;</td>
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<td>SCR controlled services</td>
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<td>6&quot;</td>
<td>12&quot;</td>
<td>12&quot;</td>
<td>24&quot;</td>
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<tr>
<td>220/440V circuits</td>
<td>6&quot;</td>
<td>6&quot;</td>
<td>adjacent</td>
<td>adjacent</td>
<td>adjacent</td>
<td>24&quot;</td>
</tr>
<tr>
<td>All other services</td>
<td>6&quot;</td>
<td>6&quot;</td>
<td>adjacent</td>
<td>adjacent</td>
<td>adjacent</td>
<td>24&quot;</td>
</tr>
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</table>

Note: Heavy current demands in or long parallel runs with the above services may dictate greater separations to avoid interference in the Systems. Separations must be maintained until within six feet of box or gutter entry.

D. Contractor must have written authorization from the Systems Designer for any conduit installation which does not conform to these requirements. The conduit separations above are based on the use of EMT conduit for all AV and other signals. Separations where Rigid conduit is utilized for AV systems and/or other adjacent systems may be halved. Separations where PVC conduit is utilized for AV systems and/or other adjacent systems must be doubled. The Contractor must request information on separation adjustments for each instance where a different type of conduit than what is listed above is used.

3.5 ELECTRICAL POWER

A. Review and coordinate electrical power system installation including grounding with the electrical contractor to ensure proper operation of the Systems.

B. Verify that all AC power circuits designated for Systems equipment are wired with correct polarity and isolated ground. Report in writing any discrepancies found to the Architect for corrective action.

C. Provide distribution of electrical power within the equipment racks with a minimum of one spare AC receptacle for each four in use per branch circuit.

3.6 STEEL SUPPORTS

A. Fabricate and install any supports so that the installation does not weaken or overload the building structure. Do not impose the weight of equipment or fixtures on supports provided for other trades or systems. No drilling or cutting of concrete beams, joists, or structural steel, nor welding to structural steel, will be permitted except as authorized, in writing, by the Architect.

3.7 BOXES

A. With the exception of portable equipment, all boxes, conduits, cabinets, equipment and related wiring shall be held in place and the mounting shall be plumb and square.

B. All boxes shall be securely mounted to building structure. All boxes shall be installed so that wiring contained in them is accessible. Install blanking devices or threaded plugs in all unused holes.
C. Wiring groups and circuits shall be isolated as indicated herein. Common pull or junction boxes are not permitted except as authorized, in writing, by the Systems Designer.

D. Clean all box interiors before installing plates, panels or covers.

E. Using permanent marker on the box or on wire tags, indicate the lengths of installed cable for all COAX and Category wiring inside the box.

F. Using permanent marker, inside the box, indicate the box name, for example “AA”.

3.8 WIRING METHODS AND PRACTICES

A. Provide installation of all Systems wire and cable, ensuring proper:
   1. Pulling Tensions
   2. Quantities
   3. Types
   4. Lengths
   5. Routing
   6. Wire Group Separation
   7. Identification

B. The interconnection of equipment in a rack shall use the same wire by type as specified for runs external to racks unless otherwise indicated on AV single line drawings. All wiring within racks shall be direct between devices without splices.

C. Interconnection wire between amplifiers and loudspeaker transition panels will be type LSXFR (refer to wire types on AV0.01).

D. Connector polarity shall be maintained except for terminations at equipment manufactured to other standards. In the event that manufactured equipment can be ordered with, or internally set to, various standards, the equipment shall be configured as follows:
   1. Polarity for XLR style connector shall be: pin 2-high, pin 3-low, and pin 1-shield.
   2. Polarity for TRS style connector shall be: tip-high, ring-low, and sleeve-shield.

E. Spare wire runs of each group and type shall be pulled to each termination location. The number of spares shall be ten percent of those in actual use or one, whichever is greater.

F. Splicing of cables is not permitted between terminations of specified equipment.

G. Do not pull wire or cable through any box fitting or enclosure where change of raceway alignment or direction occurs without written approval from the Systems Designer; do not bend conductors to less than recommended radius. Employ temporary guides, sheaves, and rollers to protect cables from excess tension, abrasion or damaging bending during installation.

H. Provide wire pulling lubricants and pulling tensions in accordance with the wire and cable manufacturer's recommendations.

I. All wires shall be permanently identified at each wire end by marking with self-laminating adhesive labels fully covered with clear heat shrink tubing, and a chart kept of each wire’s function. This applies to wire within a rack assembly as well as wire running in conduit.

J. Wire ends should be wrapped with heat shrink tubing. Each shield or drain wire should be covered with heat shrink to avoid unintentional connections.

K. Use Wago or Entrelec DIN rail mounted terminal blocks for all terminal block wiring connections. Do not exceed one wire per terminal connection point. Do not cut strands from conductors to fit lugs or terminals. Spare terminal blocks, equivalent to 10% of those in actual use, shall be provided.

L. Form, in an orderly manner, all conductors in enclosures and boxes, wire ways and wiring troughs, providing circuit and conductor identification. Tie using wraps of appropriate size and
type. Limit spacing between ties to six (6) inches and provide circuit and conductor identification at least once in each enclosure.

M. Provide service loops, minimum 6', at each termination so that plates, panels, patch bays, and equipment can be dismounted and placed on an adjacent horizontal work surface allowing for safe service and inspection without disconnection.

N. Maximum installed length of Category cables is 200'

O. Maximum installed length of Coaxial cable for HD-SDI, 3G-SDI, 6G-SDI, and 12G-SDI is 200'

P. Provide lengths of installed cables marked inside each termination back box using legible and permanent markings.

3.9 GROUNDING

A. Audio system wiring shall conform to the following procedures:
   1. Audio equipment AC ground pins shall connect to AC isolated ground.
   2. Audio equipment chassis shall connect to AC isolated ground or rack frames.
   3. Audio rack frames shall connect to AC isolated ground bus in panelboard by means of #2 gauge (minimum) conductor.
   4. Audio shields between AC powered pieces of equipment, where signal shield is tied to chassis ground, shall be directly connected to ground at the initiating end only. Capacitively terminate the receiving end with a 0.1µF capacitor.
   5. Audio signal paths between AC powered pieces of equipment shall be connected using balanced lines and/or transformer isolation as required. No unbalanced signal paths may be connected to the patch bay.
   6. Isolate all Systems wiring from racks, back boxes and conduit.
   7. Isolate all Systems racks from conduit and other conductive surfaces. Use insulated bushings for conduit connections and a dielectric plinth between racks and conductive flooring materials.
   8. AC isolated ground system shall be isolated from all other facility grounds except at the single point of connection at the AV isolation Transformer.
   9. All metallic conduit, boxes and enclosures shall be grounded in accordance with the current National Electrical Code.

B. Metallic enclosures containing active equipment shall be grounded with due regard for the minimization of electrical noise. This may include the provision of grounding conductors separate from the AC ground.

3.10 EQUIPMENT RACKS

A. The equipment racks shall be considered as custom assemblies and shall be assembled, wired and tested in the Contractor's shop. Assembly of racks on-site will not be permitted, without written approval from the Systems Designer (except for system wiring which must terminate directly to the patch bays via soldering, punch-down or other non-connectorized termination process).

B. Placement of equipment in equipment racks, as shown in the drawings, is for maximum operator convenience. Verify any changes in placement of the equipment with the Systems Designer before assembly.

C. Racks shall be installed plumb and square without twists in the frames or variations in level between adjacent racks.

D. All wire, cable, terminal blocks, rack mounted equipment, and active slots of card frame systems shall be clearly and logically labeled as to their function, circuit, or system. Labeling on manufactured equipment shall be by engraved plastic laminate or by thermal printer on adhesive tape, with white lettering on black background or dark background that is similar to panel finish.
E. Provide stiffeners to custom panels to prevent panel deformation during normal plugging or switching operations.

F. All wires and cables used in assembling custom panels and equipment racks shall be formed into harnesses which are tied and supported in accordance with accepted engineering practice.

G. Harnessed cables shall be combed straight, wrapped every six (6) to ten (10) inches, and attached to the structure as necessary. Each cable that breaks out from a harness for termination shall be provided with an ample service loop so that panels, patch bays, and equipment can be dismounted and placed on an adjacent horizontal work surface allowing for safe service and inspection without disconnecting.

H. Harnessed cables shall be formed in either a vertical or a horizontal relationship to equipment, controls, components or terminations.

I. Cable shields shall be connected to the isolated ground system with due regard for ground loops. (See Giddings reference book, Chapter 10)

J. All system components and related wiring shall be located with due regard for the minimization of induced electro-magnetic and electrostatic noise, for the minimization of wiring length, for proper ventilation, and to provide reasonable safety and convenience for the operator.

K. All rack mounted equipment, with front panel controls, shall be provided with security covers to avoid tampering with preset levels. If specific security covers are not included in the equipment list, the Contractor will provide the manufacturer's security cover for each specified device or a suitable alternate.

L. Every device shall be installed with regard for proper polarity. Absolute polarity shall be maintained through the entire Systems signal chain.

M. Any permanently mounted electronic device must be balanced. Contractor will provide balancing transformers for unbalanced equipment connections where necessary.

3.11 VERIFICATION TESTS

A. Test each point to point wire segment individually, and test any linkage of multiple point to point cables that form an end to end link.

B. Contractor must document all verification test requirements and results for submission (see 3.13.A below).

C. Confirm that each individual wire and cable run (whether in a rack or in conduit) is identified with a unique number. These numbers are affixed to both ends of each cable and are clearly visible. Provide a complete list of these numbers along with the termination location of each end of the wire run.

D. Verify all circuits and extensions for correct connection, continuity and polarity. Absolute polarity must be maintained between all points in the system.

E. Identify installed length of all copper and fiber cabling.

F. Confirm that all system outputs are free of spurious signals including oscillations and radio frequency signals. A wide band oscilloscope shall be used to verify this condition.

G. Confirm that the system is free of audible clicks, pops, and other noises when any operating control is activated, with or without input signal.

H. For all microphone lines, tie lines, return lines and effect loudspeaker lines, confirm:
   1. Proper circuits appearing at each termination location
   2. Proper circuits appearing at each jack bay position
   3. Continuity of all conductors
   4. Proper polarity is maintained
5. Absence of shorts between conductors within each circuit  
6. Absence of shorts between circuit conductors and conduit  
7. Perform a sweep test to 0.5MHz  

I. For RF Coaxial cabling confirm:  
1. Receptacles output does not exceed +15dBmv (50-400MHz - +6 dBmv minimum, above 400MHz - +3dBmv minimum)  
2. For each modulated video output, tap to meet +9dBmv (+/- 3dBmv)  
3. Verify that all TV channels are visible and free of any interference or signal distortion  
4. Frequency sweep test from 5MHz to 1000MHz.  

J. For all other Coaxial cabling confirm:  
1. Verify that the installed cable meets, at a minimum, the requirements set forth in SMPTE ST 2081 for 6G-SDI single-link and 12G-SDI dual-link.  
2. Verify that TDR impedance is 75 +/-3 ohms  
3. Frequency sweep test from 5MHz to 6GHz.  

K. For Category Cabling:  
1. Use Category 6A cable pair tester to verify compliance with TIA/EIA standards referenced above (including all current addendums)  
2. Test each cable using the permanent link procedure for opens, shorts, reversals, cross twists and mis-wiring. Check NEXT, ELFEXT, Delay Skew, Return Loss, and Alien Crosstalk.  
3. Report all mis-wiring or failures found and report retests as needed.  
4. If any conductors report open or short, replace the entire wire and re-test.  

L. For Fiber cabling:  
1. Using appropriate test devices and proper factory terminated jumpers, measure all fiber optic line attenuations, end to end, as required by TIA/EIA-526-14A.  
2. Optical budget may not exceed the cable performance by length plus splice and connector losses (0.03 dB for each fusion splice, 0.3dB for each mechanical splice, and/or 0.4 dB for each connector).  
3. Overall attenuation must meet TIA/EIA-568B standards. Perform attenuation tests at 850nm and 1300nm.  

M. Confirm that loudspeakers and mountings are free of buzzes and rattles when the loudspeaker is swept with sine wave tones over its rated bandwidth at one-half (1/2) its maximum rated power.  

N. For all permanently mounted loudspeaker terminations, provide impedance measurement of each pair of loudspeaker lines with all loudspeakers connected and all amplifiers disconnected. These measurements shall be documented as editable tabular data listing impedance for each 1/3 octave band from 20 Hz to 20 kHz and shall be accurate to the nearest tenth of an Ohm.  

O. For all intercom terminations, confirm proper operation by initiating and receiving audio communication and call light. For single lines connected to a matrix, test each line with each channel in the matrix. Verify that all channels are quiet and without spurious noise.  

P. For all electronic devices mounted in racks and connected to patch bays, confirm:  
1. Every input and output is balanced.  
2. Proper polarity is maintained throughout the entire audio path.  
3. Tip connection of each TRS jack is connected to the positive terminal of each corresponding input or output.  

Q. For all devices requiring IP addressing:  
1. IP addressing scheme must make use of subnets such that all devices, regardless on which network (Audio, Video, Control, or House) they reside, have a unique IP address to
eliminate the possibility of duplicate IP addresses if networks are inadvertently cross-patched.
2. All devices must have static IP addresses.
3. Create a spreadsheet of all devices and their IP addresses, Subnet Masks, MAC Addresses, and other pertinent IP configuration information.
4. Coordinate all IP addressing schemes with the Owner.

R. If the Audio, Video, and Control network switches are dedicated to these systems and the systems do not rely on Owner furnished and configured network switches:
1. Configure network switches to operate properly and provide the proper network configurations to support the network devices and protocols used by those devices.
2. Configure, as needed, VLANS, IGMP, QOS, and other protocols requiring configuration to provide a fully functioning and robust network system.
3. With all networks configured and operating, and all network devices configured and operating, confirm that the networks are behaving as expected and as required.

S. Electrical Contractor, coordinating with the Systems Contractor must confirm that there are no shorts between the Neutral and Isolated Ground conductors, and between the isolated ground conductor and building ground for each AV Technical Power circuit. Electrical Contractor, coordinating with the Systems Contractor must confirm there are no Bootleg Grounds or Neutral-Ground Reversals on each AV Technical Power circuit.

T. The Contractor is responsible for the programming and configuration of all DSP systems and control systems necessary as specified in this project specification and AV large format drawings.
1. Programming and configuration must be complete and ready prior to System Designer’s arrival for verification of functionality and acceptance testing.
2. Programming for the DSP systems must contain control pages to support normal operations, and to support Acceptance Testing and System Tuning operations, as described in this specification and the large format AV drawings.
3. Programming for the Control Systems must include all master controller code and touch panel code and graphics, working together to provide the function as described in this specification and the large format AV drawings.

U. Test all Audio, Video, and Control system controls, including but not limited to mixing consoles, switchers, routers, touch panels, paging stations, volume controls, and source selectors for proper operation.

V. Test proper operation of any portable controls at each designated control location (Stage Manager’s rack, for example).

3.12 INITIAL ADJUSTMENT

A. All initial adjustments must be documented and submitted as part of the Verification Test Reports (see 3.13).

B. Make all adjustments and modifications so that the system is operational and fully functional including but not limited to:
1. Update all device software and firmware to the latest manufacturer’s recommended release that allows for proper operation with ALL OTHER DEVICES in the systems.
2. Make all adjustments and modifications for system gain structure per recommendations of major component manufacturers.
3. Properly configure all EDID and HDCP settings to allow for proper function of all video systems.
4. Install all programming for digital mixing consoles, DSP, Control and any other software based devices in the systems, and verify that audio and video signal passes as designed through these systems. Verify that control systems function as specified. Contractor to provide initial DSP and control system programming prior to acceptance testing, one full
set of programming changes and adjustments, prior to handover to the Owner, and one additional set of changes and adjustments during the initial warranty period, as part of the base scope of work.

5. Properly balance all 70 Volt loudspeaker zones to be consistent from zone to zone using amplifier settings and loudspeaker taps to adjust for differing loudspeakers or installation height. All 70 Volt loudspeakers within a given zone must not have a broadband SPL variation of greater than +/- 2dB.

6. Properly adjust delay and equalization for all loudspeaker systems using SIM, SMAART or other similar dual FFT type measurement devices. All testing and adjustment shall be in accordance with all manufacturer recommendations and industry standard practice. Contact the Systems Designer for further system delay and equalization requirements.

7. Capture traces showing magnitude and phase response for each loudspeaker or loudspeaker cluster before and after equalization and delay adjustments.

8. Capture traces showing magnitude and phase response for the systems operating as a whole from 3 locations in each major seating area. One of these areas should be the House Mix Position, if applicable.

9. Equalization and timing of the loudspeaker systems shall be further adjusted as required by the Systems Designer and Owner during Acceptance Testing.

3.13 VERIFICATION TEST REPORT

A. Submit written report detailing the results of Initial Adjustments and Verification Tests. Report to include, at minimum, the following:
   1. Copies of all relevant drawings, charts, test instrument data, and photographs.
      a. PDF copies of all available manufacturers’ operation and service literature for each major system component.
      b. Copy of all programming files including, but not limited to, Audio DSP programming and Graphic User Interface (GUI) files, Control system Touch Panel GUI files and control system control programming files including un-compiled source codes.
      c. All other documentation and results of testing and initial settings as referenced in 3.11, and 3.12 above.
      d. Written certification that the installation conforms to the requirements stated herein, is complete in all respects, and is ready for inspection, Acceptance Testing, and tuning.
   2. Prepare and submit an InfoComm standard Commissioning Checklist for each system in this specification.
   3. Prepare and submit a training syllabus for Owner training (see section 3.15).

B. This report shall be completed and submitted to the Systems Designer for review a minimum of five (5) days prior to Acceptance Testing and final tuning.

3.14 ACCEPTANCE TESTING

A. Acceptance Testing shall be performed by the Systems Designer and Contractor during a period designated by the Architect. Contractor shall furnish a minimum of two (2) technicians or one technician per Systems Designer commissioning team, for the acceptance testing period, and one or more engineers fully capable of programming DSP and Control systems, and making any other engineering adjustments to equipment in the systems. Contact Systems Designer for number of commissioning teams that will be deployed. For Bid purposes assume there will be two (2) commissioning team(s).

B. The minimum time required for Acceptance Testing is ten (10) working days, including five (5) days of dedicated quiet time. Coordinate this time period so that free access, work lighting, and electrical power are available on the site.

C. Ensure that Systems areas are in a clean and orderly condition ready for acceptance testing.
D. Provide test equipment (meeting the following minimum specifications) on site, at all times during Acceptance Testing. Prior to Acceptance Testing, provide the Systems Designer with a listing of the specific equipment to be made available (**).

1. Oscilloscope: 10MHz Bandwidth, Sensitivity – 1mV/cm
2. Digital Multi-meter: 1% Accuracy
3. Function Generator: 1MHz Bandwidth, Distortion < 1%
4. Real Time Analyzer: 1/3 Octave with microphone
5. SMAART Analysis package with V.8 software and a minimum of two matching test microphones (Earthworks M30 or better)
6. Pink Noise Source: 20 Hz – 20 kHz Bandwidth
7. Test mic tone calibrator
8. Impedance Sweep Meter: 20 Hz – 20 kHz Range, 1 Ohm – 50 kOhm
9. Polarity Checker: Mic, line, or loudspeaker level
10. Video Test Signal Generator(s): must provide all signals, resolutions, and output formats as needed to fully test the systems.

** Note: Systems Designers may choose to supply some of their own test equipment. Confirm specific requirements prior to commissioning.

E. Be prepared to verify the performance of any portion of the system by demonstration, listening tests and instrumented measurements.

F. Be prepared to facilitate the visual inspection of system components and wiring, including removal of termination panels for inspection of wiring termination and wire management practices.

G. Be prepared to demonstrate all software and control systems.

H. Be prepared to go through the commissioning checklist and verify all items as complete.

I. Make additional mechanical and electrical adjustments within the scope of the work and which are deemed necessary by the Systems Designer as a result of the Acceptance Tests. This may include realigning of loudspeaker systems, changes in system gain structures, grounding, filtering or interfaces.

J. Final acceptance will be contingent upon issuance by the Systems Designer of a letter of acceptance stating that the work has been completed and is in accordance with the contract documents.

K. Contractor will bear any costs incurred for additional Systems Designer's time and expenses due to failure to have the system functioning in accordance with specification requirements at the times scheduled for Systems Designer's Acceptance Testing.

3.15 USER TRAINING

A. Contractor will provide in-depth training in operation and regular maintenance of all systems and on all equipment included in the scope of work contained in this specification and the AV large format drawings.

B. Training to include (but is not limited to):

1. Detailed operation of mixing consoles, video switchers and routers, computer control systems and other essential system elements as relevant to their installation in this project.
2. Maintenance and repair of system equipment, including replacement procedures for user-replaceable parts.
3. Review of Operation and Maintenance Manual (See 3.16)

C. Contractor will provide a minimum of four (4) training sessions of four hours each with times and dates to be approved by the Owner.
D. The first session shall take place in the presence of the Systems Designer and shall occur directly after the completion of Acceptance Testing. If the Systems Designer, Owner, and/or Architect judge any work to be deficient and/or not substantially complete at the time scheduled for training, the training will be postponed until the Systems Designer, Owner, and Architect judge the entire AV system conforms to this specification and the AV large format drawings.

E. Contractor will bear any costs incurred for additional Systems Designer’s time and expenses due to failure to have the system functioning in accordance with specification requirements at the times scheduled for User Training.

3.16 SYSTEM DOCUMENTATION

A. Within thirty (30) days of the Acceptance Testing, prepare and submit a CD-ROM of the preliminary Operation and Maintenance manual for approval by the Systems Designer. Manual to include, at minimum, the following documents in PDF format:
   1. Table of contents
   2. Written Guarantee and service policy
   3. Basic power on/off and operational procedure
   4. Copies of all shop drawings which have been updated to include any changes made during the installation process
   5. All available manufacturers’ operation and service literature for each major system component
   6. One line signal flow diagram with all cable runs and patch points identified by alpha-numeric character
   7. Copy of the Verification Test report
   8. Copy of conduit riser diagram
   9. Copy of the final tuning settings as provided by the Systems Designer
   10. Copy of the IP Addressing table
   11. Copy of all uncompiled source codes and configuration files which have been updated to include any changes made during the installation process.

B. Systems Designer will review the above system documentation. Upon approval, Contractor shall prepare and submit to the Owner:
   1. Five (5) copies of the final Operation and Maintenance manual on CD-ROM or DVD.
   2. Two (2) hard copies of the final Operation and Maintenance manual printed and neatly bound

C. Provide framed or laminated copy of the as-built signal flow diagram for each theater to be mounted in each control room. This diagram shall have all cable runs and patch points identified by alpha-numeric character.

APPENDICIES TO FOLLOW
SECTION 27 41 00 – APPENDIX A
PERFORMANCE AUDIO/VIDEO SYSTEMS FUNCTIONAL DESCRIPTION

INTRODUCTION

This document outlines the AV system criteria for the programmed spaces for the Gateway Theater Complex (GTC) at Wayne State University (WSU). This narrative will offer a general overview of the AV systems included within each venue of the facility.

The AV systems have been designed from programming documentation and discussion with the end users, providing a highly flexible yet easy to use series of systems. These systems are designed to operate 24 hours a day, 7 days a week, and to facilitate continuous and simultaneous use of the entire Gateway Theater Complex, be it for performance or pedagogic need.

To facilitate understanding, the document is broken down into sections. These sections are as follows:

Part Description
1. Facility Wide Systems
2. Public Spaces
3. Valade Jazz Center
4. Proscenium Theater
5. Black Box Theater
6. Theater Support Spaces

1 - FACILITY WIDE SYSTEMS

The Gateway Theater Complex is designed as a fully integrated facility for the music and performing arts. To achieve this goal, many of the AV technical systems are interconnected, allowing fluid exchange of audio and video material for performance and pedagogical use. Systems that overlap operation, as well as systems that bridge performance venues in front-of-house and back-of-house areas are described below:

Isolated Ground for AV systems
All audio and video systems are powered by a separate Audio & Video Technical Power system (AVTP) to ensure noise-free operation. The AVTP system runs on a dedicated transformer and all associated outlets utilize dedicated isolated ground wires and hospital-grade outlets. The AVTP system is used only for audio and video equipment. The AVTP System also includes stage disconnects (company switches) in major performance spaces to facilitate outside events. Design of system and location of transformer (and if it is several) to be coordinated with the EE.

Video Transport & Matrix System
The GTC features a networked video transport and matrix system allowing staff and users a flexible and efficient approach to routing media feeds around the facility, for production, education or future streaming/broadcast use. The system uses a series of networked video encode and decode devices that patch to a facility wide video LAN. Interconnections are achieved through a control software, digitally connecting or disconnecting feeds from and to any room within the Complex.

Digital Intercom & Program/Page Matrix
Communication is key for the creation of performance and music arts. The GTC uses a state of the art digital intercom matrix to allow art makers an efficient, instantaneous ability to connect with other artists through multi-channel communication among technical operating personnel using headsets with boom-mounted microphones. Station and plugin ports are provided for all technical operating positions on the stages, and in booths and backstage support areas. Although each performance space has individual channels of intercom for their respective productions, the system can also combine communication needs
between rooms, allowing the Complex to operate collaboratively – all at once, or in specified zones. Wireless capabilities are also included, allowing flexible and mobile communication needs in each performance space and support space.

The back of house program and page system provides support spaces (control rooms, green & dressing rooms, etc) real time audio monitoring of activities taking place within the performance venues. The volume of the program feed can be adjusted locally, however a priority page system is in place to ensure any and all announcements or calls by the stage management team will be heard by the artists. For those support spaces that serve multiple performance halls, control system assignment is provided allowing personnel to choose which feed is appropriate for the space at that time.

**Owner Furnished Equipment**

The Gateway Theater Complex contains a great deal of owner furnished equipment for performance AV use in the various spaces. Much of this equipment is quite similar in nature and operation. Portable equipment is intended to be assigned to specific areas/rooms, however the operation of the facility relies on the sharing of certain types of equipment when areas/disciplines/halls are not in simultaneous use. This is done to provide the most efficient portable equipment solution for WSU, and limit the amount of doubling up required.

**AV Equipment Racks**

An audio/video equipment rack room is provided as the hub for:

- The digital signal processors ("DSP") used to time align, “tune” and control the main loudspeaker systems. These devices are selected for compatibility with the primary mix console and loudspeakers.
- Control and processing for the auxiliary systems, which includes ADA-compliant listening assistance, production intercom and backstage and lobby program and paging systems.
- The video distribution network system.
- Amplifiers for the main and auxiliary audio systems.

### 2 - PUBLIC SPACES

**Lobby**

Lobbies for performance spaces include monitoring capability (audio and video) to the adjacent performance hall, along with house manager page abilities. Video displays for digital signage, and latecomer show-relay are positioned adjacent to each performance space.

**Front-of-House Support**

The front-of-house support spaces have production intercom capabilities and selectable program and page feeds from the performance venues, allowing staff to monitor and communicate with backstage and stage management personnel as required. Designated front-of-house support spaces are as follows:

- Box Office
- Building Manager Office
- Production & Technical Director Offices

**Donor Lounge**

The Donor Lounge has selectable program and page feeds from designated Theatre performance spaces, allowing flexible use for any event taking place within the Complex. These rooms also have video displays able to show video relay feeds from the assigned performance space, as well as wireless presentation for private events.
3 – VALADE JAZZ CENTER

Performance Audio System
The audio system is designed to provide critical listening at moderately higher outputs for reinforced music.

- Left/right ("LR") main loudspeakers are suspended from the catwalk at the downstage edge of the stage to provide the majority of sound to the audience.
- Supplemental loudspeakers extend the reach and frequency content of the LR arrays. Typically these supplemental loudspeakers are from the same manufacturer as the main arrays to help facilitate uniform voicing.
  - Left and right out fills are located adjacent to the main loudspeakers to provide coverage to the outer edges of the audience chamber.
  - Left and right subwoofers extend low-frequency content for music.
  - Small portable loudspeakers incorporated in the stage lip provide imaging and intelligibility in the first few rows of seating.
- Connections for loudspeakers are provided around the stage and in the catwalks. These are used to connect portable monitor wedges and other loudspeakers, as needed.
- Connections for microphones and other input devices are provided around the stage and in the catwalks.
- A permanent in house mixing area will be located at the rear of the audience chamber.

Hearing Assistance System
This system transmits stage sound or other selected program material by means of radio frequency carrier to individual receivers provided for the hearing impaired. Alternate uses of the system include transmission of a second language or of audio descriptions for the sight impaired.

Intercom System
The system will have the capabilities and connections available to the overall Digital Intercom Matrix for the Gateway Theater Complex as described in the Facility Wide Systems section of this document.

Live Room Microphone System
A stereo microphone suspended in the audience chamber picks up signals from all performances, both amplified and unamplified. Signals from this source are distributed to a number of auxiliary systems, including hearing assistance, intercom, and the Program/Page Matrix. In addition, this source can be used to feed an archival recording system.

Recording Microphone System
To accommodate music performance recording, recording microphone inputs are provided in strategic locations in the catwalk for archival or broadcast recordings. Several studio-quality microphones can be suspended in the venue to pick up the sound of performances for archival and critical recording purposes. Signals from these sources can be patch to recording equipment.
Performance & Production Video

Video functions include lecture projection use, digital video, projected scenery, cinema, archival recording, and local-access broadcast.

- Projectors and screens will be provided by WSU. A number of portable networked video encoders and decoders will be provided to facilitate video input and output between devices and the video network.
- A projector slide can be accessed from the control booth keeping the sound of the projector isolated from the audience chamber.
- Connections for portable video (for temporary displays and camera locations) are provided around the stage and orchestra pit, in the catwalks and around the seating areas. These are used to connect portable devices, as needed such as conductor camera and confidence monitors.
- A permanent high-resolution camera is provided mounted at the back of the audience chamber, along with a lower-resolution camera capable of infrared imaging.

Valade Equipment Rack

An audio/video equipment rack room is provided for:

- The primary patch-bays used to interconnect the various input and output locations around the stage, catwalks, and audience chamber.
- Control and processing for the auxiliary systems, which includes ADA-compliant listening assistance, and backstage and lobby program and paging systems.
- Amplifiers for the main and auxiliary audio systems.

Loose Equipment

Wired and Wireless Microphones, DI boxes, cables, stands, effects loudspeakers and monitor wedges; portable video equipment; portable musical instruments; and other equipment appropriate to the program are provided.

Office/Dressing/Changing Rooms

Each of the rooms contains a program/page feeds from the Valade Jazz Center. This system provides audio relay of activities taking place within the halls, and can accept stage manager page, as discussed in section Facility Wide Systems of this document.

4 - PROSCENIUM THEATRE

Performance Audio System

The audio system is designed to fill multiple requirements — subtle voice lift for lectures and drama, moderately higher outputs for reinforced music, and controlled vocal imaging and sound effects for musical theater.

- Left/center/right (“LCR”) main loudspeakers are installed around the proscenium to provide the majority of sound to the audience.
• Supplemental loudspeakers extend the reach and frequency content of the LCR arrays. Typically these supplemental loudspeakers are from the same manufacturer as the main arrays to help facilitate uniform voicing.
  o Left and right subwoofers extend low-frequency content for music and effects. These are rigged from the forestage catwalk.
  o Small portable loudspeakers can be deployed along the stage lip or along the orchestra pit rail to provide imaging and intelligibility in the first few rows of seating. These speakers will transition between the stage face and the orchestra pit lift to accommodate multiple configurations.
• Connections for surround-sound effects and monitor loudspeakers are provided around the stage and orchestra pit, in the catwalks and around the seating areas. These are used to connect portable loudspeakers, as needed.
• Connections for microphones and other input devices are provided around the stage and in the catwalks.
• A mixing area will be located in the audience chamber at the cross aisle. This allows for in-house mixing of audio-critical shows (musical theatre and popular music events) with minimal loss of seats or sightline issues.

Hearing Assistance System
This system transmits stage sound or other selected program material by means of radio frequency carrier to individual receivers provided for the hearing impaired. Alternate uses of the system include transmission of a second language or of audio descriptions for the sight impaired.

Intercom System
The system will have the capabilities and connections available to the overall Digital Intercom Matrix for the Gateway Theater Complex as described in the Facility Wide Systems section of this document.

Live Room Microphone System
A stereo microphone suspended in the audience chamber picks up signals from all performances, both amplified and unamplified. Signals from this source are distributed to a number of auxiliary systems, including hearing assistance, intercom, and the Program/Page Matrix. In addition, this source can be used to feed an archival recording system.

Performance & Production Video
Video functions include lecture projection use, digital video, projected scenery, cinema, archival recording, and local-access broadcast.

• Projectors and screens will be provided by the owner. A number of portable networked video encoders and decoders will be provided to facilitate video input and output between devices and the video network.
• Power and connection panels in the projector booth allow the setup and operation of multiple projectors through projection rated glass.
• Connections for portable video (for temporary displays and camera locations) are provided around the stage and orchestra pit, in the catwalks and around the seating areas. These are used to connect portable devices, as needed such as conductor camera and confidence monitors.
• A permanent high-resolution camera is provided mounted at the back of the audience chamber, along with a lower-resolution camera capable of infrared imaging.

Theater Booth and Rack Rooms

• The control booth houses live mixing and playback equipment, including:
  o A medium format digital mixing console. This console can be relocated to the house mix position (see above) when needed.
  o Playback and recording on CD as well as hard-disk based effects playback.
  o The primary patch-bays used to interconnect the various input and output locations around the theater.
  o Booth audio, including monitoring for the audio and lighting operators and the stage manager.
• A stage rack is provided for:
  o The primary patch-bays used to interconnect the various input and output locations around the stage, orchestra pit, trap room and loading gallery

Proscenium Theater Loose Equipment

Wired and Wireless Microphones, DI boxes, cables, stands, effects loudspeakers and monitor wedges appropriate to the program are provided by the owner.

5 – BLACK BOX THEATER

Performance Audio System
The audio system is designed chiefly to provide playback of sound effects for theatrical productions. The audio system contains the following equipment:

• Connections for loudspeakers around the stage and at the grid. These are used to connect portable loudspeakers, as needed to suit the production sound design requirements. Loudspeakers will be provided by owner from existing inventory, however, new amplifiers have been provided for ease of patching and future console and loudspeaker upgrades.
• Connections for microphones and other input devices are provided around the stage and at the grid.
• A temporary mixing connection can be patched from the stage deck to the booth equipment rack. This allows for in-house mixing of audio-critical shows.

Hearing Assistance System
This system transmits stage sound or other selected program material by means of radio frequency carrier to individual receivers provided for the hearing impaired. Alternate uses of the system include transmission of a second language or of audio descriptions for the sight impaired.

Intercom System
Along with local intercom capabilities, the system will have the capabilities and connections available to the overall Digital Intercom Matrix for the Gateway Theater Complex as described in the Facility Wide Systems section of this document.
Live Room Microphone System
A microphone suspended in the audience chamber picks up signals from all performances, both amplified and unamplified. Signals from this source are distributed to a number of auxiliary systems, including hearing assistance, intercom, lobby, and the Program/Page matrix.

Performance & Production Video
Video functions include performance and lecture projection use (such as PowerPoint), digital video, cinema, and local-access broadcast.

- Projectors and screens will be provided by the owner. A number of portable networked video encoders and decoders will be provided to facilitate video input and output between devices and the video network.
- A permanent high-resolution camera is provided mounted, along with a lower-resolution camera capable of infrared imaging.
- Connections for portable video (for temporary displays and camera locations) are provided around the stage and at the grid. These are used to connect portable devices, as needed.

Control Booth and Rack Rooms

- The control booth houses live mixing and playback equipment, including:
  - A small format digital mixing console. This console can be relocated to the house mix position when needed.
  - Playback and recording on CD and hard-disk.
  - The primary patch-bays used to interconnect the various input and output locations around the theater.
  - Booth audio, including monitoring for the audio and lighting operators and the stage manager.

Blackbox Theatre Loose Equipment
Wired and Wireless Microphones, DI boxes, cables, stands, effects loudspeakers and monitor wedges appropriate to the program are provided.

6 – THEATER SUPPORT SPACES

Equipment Racks
An audio/video equipment rack room is provided as the hub for:

- The digital signal processors ("DSP") used to time align, “tune” and control the main loudspeaker systems. These devices are selected for compatibility with the primary mix console and loudspeakers.
- Control and processing for the auxiliary systems, which includes ADA-compliant listening assistance, production intercom and backstage and lobby program and paging systems.
- The video distribution network system.
- Amplifiers for the main and auxiliary audio systems.
Dressing Rooms
Each of the dressing rooms contains selectable program/page feeds from the Proscenium Theatre or Black Box Theatre. This system provides audio relay of activities taking place within the halls, and can accept stage manager page, as discussed in section Facility Wide Systems of this document. The Dressing Rooms also have video displays able to show video relay feeds from the assigned performance space.

Warm-Up/Green Room/Lounge
These spaces have production intercom capabilities and selectable program and page feeds from designated Theatre performance spaces, allowing flexible use for any event taking place within the Complex. These rooms also have video displays able to show video relay feeds from the assigned performance space, as well as wireless presentation where designated.

Electrics Shop
The Scene and Electrics Shop space houses the equipment rack to service all terminations in the shop/dressing room portion of the building.

END OF 27 41 00 - APPENDIX A
**SECTION 27 41 00 - APPENDIX B**

**PERFORMANCE AUDIO/VIDEO SYSTEMS MAJOR EQUIPMENT LIST**

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>MANUFACTURER</th>
<th>MODEL</th>
<th>QTY</th>
<th>STATUS</th>
</tr>
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<tbody>
<tr>
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<td>Fulcrum</td>
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<td>X-OB</td>
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<td>Surgex</td>
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<td>Surgex</td>
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### ZB - BOOTH EQUIPMENT RACK

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| Rack Light | Littlite | RL-10D-LED | 1 | CFCI |
| Fiber Patch | Black Box | JPM385A | 4 | CFCI |
| Fiber Patch Cable | By Contractor | Dual LC to Dual LC - 2' MMF | 12 | CFCI |
| Fiber Patch Cable | By Contractor | Dual LC to Dual LC - 2' SMF | 12 | CFCI |
| Category Patch | Black Box | JPM700A | 7 | CFCI |
| Category Patch Keystone | Black Box | FMT700 | 168 | CFCI |
| Category Patch Cable | By Contractor | 2' Shielded Cat6A | 36 | CFCI |
| Category Patch Cable | By Contractor | 3' Shielded Cat6A | 24 | CFCI |
| Audio Patch | Audio Accessories | WEP-262EO-SH-JSK | 2 | CFCI |
| Audio Patch Cable | Audio Accessories | 621B | 8 | CFCI |
| Audio Patch Cable | Audio Accessories | 622A | 8 | CFCI |
| Audio Patch Cable | Audio Accessories | PCH-X | 1 | CFCI |
| Accessory Patch Panel | Custom | APD | APD | CFCI |
| RF Mic Antenna Patch | AVP | WK-U116E2-Z | 1 | CFCI |
| PoE+ Managed Switch | Cisco | SG350-28MP w/ SFP's | 1 | CFCI |
| PoE+ Managed Switch | Cisco | SG350-52MP w/ SFP's | 2 | CFCI |
| Network Video Switch - Video | Netgear | M4300-48X w/ SFP's | 1 | CFCI |
| Touch Panel | QSC | TSC-80w-G2 | 1 | CFCI |
| Rackmount Display/Keyboard/Touch Pad | Middle Atlantic | RM-KB-LCD17HD | 1 | CFCI |
| DSP I/O | QSC | I/O 8 Flex | 1 | CFCI |
| Audio Monitor | Fostex | RM-3 | 1 | CFCI |
| Amplifier | QSC | SPA4-100 | 1 | CFCI |
| Rack Drawer w/ Lock | Middle Atlantic | DLK | APD | CFCI |
| UPS | Surgex | UPS-2000-OL | 1 | CFCI |
| UPS - IP Card | Surgex | UPS-SNMP-OL | 1 | CFCI |

### ZC - AMP ROOM EQUIPMENT RACK

<p>| Equipment Rack | Middle Atlantic | APD | APD | CFCI |
| Rack Light | Littlite | RL-10D-LED | 2 | CFCI |
| Fiber Patch | Black Box | JPM385A | 2 | CFCI |
| Fiber Patch Cable | By Contractor | Dual LC to Dual LC - 2' MMF | 12 | CFCI |
| Fiber Patch Cable | By Contractor | Dual LC to Dual LC - 2' SMF | 12 | CFCI |
| Category Patch | Black Box | JPM700A | 6 | CFCI |
| Category Patch Keystone | Black Box | FMT700 | AR | CFCI |
| Category Patch Cable | By Contractor | 2' Shielded Cat6A | 12 | CFCI |
| Category Patch Cable | By Contractor | 3' Shielded Cat6A | 12 | CFCI |
| Audio Patch | Audio Accessories | WEP-262EO-SH-JSK | 1 | CFCI |
| Audio Patch Cable | Audio Accessories | 621B | 8 | CFCI |
| Audio Patch Cable | Audio Accessories | 622A | 8 | CFCI |</p>
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<th>Equipment</th>
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<tr>
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<td>DSP</td>
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**ZF - SHOPS EQUIPMENT RACK**

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**BOH / SHOPS**

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**LOBBY / FOH**

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**PAGE AND PROGRAM**

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**STAGE MANAGER RACK**

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<td>T90B IR-LED</td>
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<td>A81WS-BLK</td>
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<td><strong>STANDS / CABLES / ACCESSORIES</strong></td>
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Performance Audio/Video Systems

Page 27 of 41 Appdx. B - 4
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<td>Gator</td>
<td>Portable case for BPs, Mics, ANT, &amp; Cable</td>
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<td>Drawer with Lock</td>
<td>Middle Atlantic</td>
<td>D#-LK</td>
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**TERMINATIONS**

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### MICROPHONES/STANDS / CABLES / ACCESSORIES

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**END OF SECTION**
SECTION 280528
PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Nonmetallic conduits, tubing, and fittings.
   3. Optical-fiber-cable pathways and fittings.
   4. Metal wireways and auxiliary gutters.
   5. Nonmetallic wireways and auxiliary gutters.
   8. Handholes and boxes for exterior underground cabling.

B. Related Requirements:
   1. Section 078400 "Firestopping" for firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
   2. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct-banks, manholes, and underground utility construction.
   3. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.

1.3 DEFINITIONS
A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.

1.4 SUBMITTALS
A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.
D. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of pathway groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

E. Qualification Data: For professional engineer.

F. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, and equipment racks and their mounting provisions, including those for internal components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
   4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

G. Source quality-control reports.

H. Refer to Section 018113 “Sustainable Design Requirements” for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

PART 2 PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   3. Anamet Electrical, Inc.
   4. Bridgeport Fittings, Inc.
   5. Electri-Flex Company.
   7. Picoma Industries; Subsidiary of Mueller Water Products, Inc.
   8. Republic Conduit.
   9. Robroy Industries
   10. Southwire Company.
   12. Western Tube and Conduit Corporation.

B. General Requirements for Metal Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-D.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. FMC: Comply with UL 1; zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for EMT:
      a. Material: Steel or Zinc die cast.
      b. Type: Setscrew or compression.
   3. EMT Fittings Materials:
      a. All Zinc materials shall be ASTM B86 certified.
      b. All Zinc Product shall be ZAMAK #3 and/or #7 formula.
      c. All Steel shall be SAE 1050.
   4. EMT Fittings Design:
      a. Zinc die cast components shall be ball burnished.
      b. Steel parts shall be zinc plated for corrosion protection.
      c. All Locknuts shall have a dual, precision machined-cut thread, reversible and possess a serrated face on each side.
      d. All set screw products shall be manufactured with a tri-drive head and staked or modified to prevent disassembly.
      e. All fitting throat diameters shall be smooth with no sharp edges or slag.
      f. Rain tight products shall have internal sealing rings to create and maintain a rain tight seal.
      g. All fittings shall be tested per UL 514B and be listed by Underwriters Laboratories.
   5. Transition Fittings:
      a. All transitions fittings (go-to or from-to fittings) or fittings used to transition from one raceway type to another must be UL listed for that application.

I. Joint Compound for IMC, or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, FITTINGS AND ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   3. Anamet Electrical, Inc.
   5. CANTEX Inc.
   6. CertainTeed Corp.
   8. Electri-Flex Company.
   10. Lamson & Sessions; Carlon Electrical Products.
   11. Niedax-Kleinhuis USA, Inc.
   12. RACO; a Hubbell Company.

B. General Requirements for Nonmetallic Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-D.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. LFNC: Comply with UL 1660.

F. Rigid HDPE: Comply with UL 651A.
G. Continuous HDPE: Comply with UL 651B.

H. RTRC: Comply with UL 1684A and NEMA TC 14.

I. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

J. Fittings for LFNC: Comply with UL 514B.

K. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

L. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Alpha Wire Company.
   2. Arnco Corporation.
   3. Endot Industries Inc.
   4. IPEX.
   5. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible-type pathway, approved for plenum installation unless otherwise indicated.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-D.

2.4 SURFACE PATHWAYS

A. General Requirements for Surface Pathways:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-D.

B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Mono-Systems, Inc.
      b. Niedax-Kleinhuis USA, Inc.
      c. Panduit Corp.
      d. Wiremold / Legrand.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Adalet.
   2. Cooper Technologies Company; Cooper Crouse-Hinds.
   3. EGS/Appleton Electric.
   5. Hoffman; a Pentair company.
   6. Hubbell Incorporated; Killark Division.
   7. Lamson & Sessions; Carlon Electrical Products.
8. Milbank Manufacturing Co.
9. Molex, Woodhead Brand
10. Mono-Systems, Inc.
12. RACO; a Hubbell Company.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:
   1. Comply with TIA-569-D.
   2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

F. Metal Floor Boxes:
   1. Material: Cast metal or sheet metal.
   2. Type: Semi-adjustable.
   3. Shape: Rectangular.
   4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
   1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.

J. Device Box Dimensions: 4-inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

K. Gangable boxes are prohibited.

L. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures:
      a. Material: Plastic or Fiberglass.
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

N. Cabinets:
   1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTerior UNDERGROUND CABLEING

A. General Requirements for Handholes and Boxes:
   1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
   2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   3. Comply with TIA-569-D.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass or a combination of the two.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armorcast Products Company.
      b. Carson Industries LLC.
      d. NewBasis.
      e. Oldcastle Precast, Inc.; Christy Concrete Products.
      f. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
   2. Standard: Comply with SCTE 77.
   3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
   4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
   5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   6. Cover Legend: Molded lettering, "ELECTRIC."
   7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete, reinforced concrete or fiberglass.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armorcast Products Company.
      b. Carson Industries LLC.
      d. NewBasis.
      e. Nordic Fiberglass, Inc.
      f. Oldcastle Precast, Inc.; Christy Concrete Products.
      g. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
   2. Standard: Comply with SCTE 77.
   3. Color of Frame and Cover: Green.
   4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
   5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
   6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   7. Cover Legend: Molded lettering, "ELECTRIC."
8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

9. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Tests of materials shall be performed by an independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC, IMC, or RNC, Type EPC-40-PVC.
   2. Concealed Conduit, Aboveground: EMT.
   3. Underground Conduit: RNC, Type EPC-80-PVC direct buried or Type EPC-40-PVC concrete encased.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC or LFNC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT or IMC.
   3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Pathway locations include the following:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
      d. Gymnasiums
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric-Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: GRC or IMC.
   7. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway, Plenum-type, communications-cable pathway or EMT.
   8. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway or Riser-type, communications-cable pathway.
   9. Pathways for Concealed General Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
   10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
C. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).

D. Pathway Fittings: Compatible with pathways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. EMT: Use setscrew or compression, steel or Zinc die-castmetal fittings. Comply with NEMA FB 2.10.
   3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20 and UL514B.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-D for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications wiring conduits for which only two 90-degree bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Pathways Embedded in Slabs:
   1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
   2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
   3. Arrange pathways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
   4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
   5. Change from ENT to IMC before rising above floor.

J. Raceways Embedded in Concrete Slabs on Composite Steel Decking:
   1. All raceways embedded in slabs shall be approved by the Architect and local building official having jurisdiction over the Project prior to installation. In no case shall the installation violate the structural integrity of the slab.
   2. Conduit must be uncoated or galvanized iron or steel not less than standard Schedule 40 steel pipe (RMC).
3. The conduit outside diameter shall not exceed 1/3 the thickness of the slab above the composite deck.

4. Conduit clear spacing must be at least three times the conduit diameter, or 3-inches minimum, whichever is greater.
   a. Maximum group size shall not exceed 6 conduits in any case.
   b. Install conduit in deck low flutes when running parallel to direction of metal deck.

5. Secure raceways to steel deck at 4'-0" o.c. to prevent sagging or shifting during concrete placement with a minimum concrete cover of at least one inch all around.

6. Piping and conduit shall be so fabricated and installed that cutting, bending, or displacement of reinforcement from its proper location will not be required.

7. Install additional layer of WWF 6x6 W2.1xW2.1 slab reinforcement over all embedded conduit groups of three or more and extending at least two feet beyond each side.

K. Raceways Embedded in Elevated Concrete Slabs:

   1. All raceways embedded in slabs shall be approved by the Architect and local building official having jurisdiction over the Project prior to installation. In no case shall the installation violate the structural integrity of the slab.

   2. Conduit must be uncoated or galvanized iron or steel not less than standard Schedule 40 steel pipe (RMC).

   3. The conduit outside diameter shall not exceed 2-inches.

   4. Conduit clear spacing must be at least three times the conduit diameter, or 4-inches minimum, whichever is greater.
      a. Maximum group size shall not exceed 4 conduits in any case.
      b. Install conduit between top and bottom reinforcing with a minimum concrete cover between conduit and reinforcing of at least 1-inch all around.

   5. Chair conduit from formwork at 4'-0" o.c. to prevent sagging or shifting during concrete placement.

   6. Piping and conduit shall be so fabricated and installed that cutting, bending, or displacement of reinforcement from its proper location will not be required.

   7. No embedded conduits of any size are allowed within 48-inches of face of columns without prior approval of Structural Engineer.

   8. Where conduit cannot be installed without violating these provisions, it shall be routed in ceiling space above or below.

L. Raceways Within 1 ½" of Roof Deck:

   1. All raceway shall be installed further from 1 ½" of roof deck or raceway shall be RMC or IMC.

M. Stub-ups to Above Recessed Ceilings:

   1. Use EMT, IMC, or RMC for pathways.

   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

Q. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to conduit assembly to assure a continuous ground path.

S. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

U. Surface Pathways:
   1. Install surface pathway for surface electrical outlet boxes only where indicated on Drawings.
   2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
   3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer’s written instructions. Tape and glue are not acceptable support methods.

V. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
   1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
   2. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
   3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

W. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

X. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service pathway enters a building or structure.
   3. Where otherwise required by NFPA 70.

Y. Comply with manufacturer’s written instructions for solvent welding PVC conduit and fittings.

Z. Expansion-Joint Fittings:
   1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
   2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
      a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
      b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
      c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
      d. Attics: 135 deg F (75 deg C) temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer’s written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a rain-tight connection between box and cover plate or supported equipment and box.

DD. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Do not install boxes back-to-back.

EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

GG. Set metal floor boxes level and flush with finished floor surface.

HH. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

II. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

JJ. Boxes installed in metal stud and sheetrock walls shall have far-side box support.

KK. Boxes shall be secured to metal studs with spring steel clamp which wraps around the entire face of the stud and digs into both sides of the stud. Clamp shall be screwed into the stud.

LL. Set outlet boxes for flush mounted devices to within 1/8" of finished wall.

MM. Minimum box size to be two gang. For installation of single gang device use properly sized mud ring with thickness to install device within 1/8" of finished wall.

NN. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

OO. Firestopping: Provided by Section 078400 “Firestopping”. Coordinate with Section 078400 “Firestopping” for sealing of penetrations through fire and smoke barriers.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312333 "Trenching and Backfilling" for pipe less than 6 inches (150 mm) in nominal diameter.

2. Install backfill as specified in Section 312333 "Trenching and Backfilling."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312333 "Trenching and Backfilling."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.

7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

### 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line, or with anchors extending below depth of frost line of 48 inches (122 cm) below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY
PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 280544 "Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078400 "Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION
SECTION 28 10 00

COMMUNICATIONS OVRVIEW

PART 1 - GENERAL

1.01 SECTION INCLUDES
   A. This section provides a project overview and general project and Contractor requirements for technology work.
   B. The “Contractor” as referred to in these specifications, shall be the bidder whose bid is eventually chosen as the winner.
   C. The “Engineer” as referred to in these specifications, shall be Commtech Design and its representative on this project.
   D. The “Owner” as referred to in these specifications, shall be Wayne State University and its representatives.
   E. In the detailed specifications and on the contract drawings, the phrases “or equivalent,” “approved equivalent,” “approved equal,” “or equal” and “engineer approved equivalent” shall be used interchangeably and shall mean the same thing.
   F. All equals, equivalents, or alternates shall be approved by the Engineer prior to ordering or installation. Without approval, deviation from the products listed in the specifications and on the drawings, shall be presumed to be nonconforming and shall be removed and replaced at the direction of the Engineer and at the Contractor’s expense.

1.02 DESCRIPTION OF PROJECT
   A. Access Control System
      1. Install access control systems in the building.
         a. Provide and install all equipment shown.
         b. Owner has the servers and software for each system in place.
         c. Work with C&IT on implementation of the systems.
      2. There shall be two distinct systems in the building.
         a. Pegasys system for the exterior doors
         b. OneCard system for the interior doors.
         c. See drawings for which doors and what devices are connected to each system.
         d. These systems shall be an expansion of the existing University systems
      3. Provide raceways as shown on the drawings.
      4. Install all cabling required connect each door to the security panels
         a. Security panels shall be located in each communications room. See drawings.
         b. Wire from each power supply to the panels and to the devices at the doors
      5. Install intercoms. Where the intercom is connected to the data network the contractor shall provide all patch cables and configure the network to support the intercoms
      6. Configure the system as per the owner’s requirements. Meet with them to determine configuration parameters
      7. The extent of the work shall be as shown on the drawing and detailed in these specifications
   B. Video Security System
      1. See drawings and specs for CAT-6 cable installation and who is responsible for installing cabling.
      2. Provide and install all cameras at all locations noted
      3. The owner has existing servers and software.
      4. Owner to provide licenses for all cameras
      5. Owner to install camera software and configure the cameras on the system. Contractor shall configure each camera with the University provided IP addresses.
      6. Provide each MAC address of the cameras to the owner.
7. The extent of the work shall be as shown on the drawing and detailed in these specifications.

C. Post installation documentation
1. Each contractor shall provide post installation documentation as per the specifications. Shall include but not be limited to:
   a. Red-lined as-built drawings
   b. As-built detailed connectivity of AV and Network Systems
   c. As-built cable locations and cable labels at each location.
   d. Mark all splice locations
   e. Update of all access control locations and equipment at each door
   f. Camera locations and camera numbers.
   g. Spreadsheet (hard copy and Excel file) for all network, Wireless, telephones and cameras detailing:
      A) Mfg. Part number
      B) IP Address
      C) MAC Address
      D) Device number (Camera #, Telephone # etc)

1.03 STORAGE OF MATERIALS
A. All materials shall be secured when not in use by the Contractor.
B. It shall be the Contractor’s responsibility to secure all equipment including all material to be installed as part of the contract. No changes shall be made to the contract due to loss or theft of equipment and materials not officially accepted by the Owner.

1.04 PERMITS
A. The State of Michigan requires that the Contractor apply for and obtain permits for data telecommunication installation.
B. This is required under State of Michigan Public Act 230. Only exemptions to the permit requirements are found in Public Act 230 MCL125.1528a.
   1. There is not a license required to apply for a permit per Public Act 407 MCL339.5737(3)(o).
D. People who can obtain the permit include the Owner of the building or a company representing the owner. See Public Act 230 MCL125.1510.
   1. Contractor shall be required to apply for and obtain the permit
   2. Contractor shall be required to install the data telecommunications system to fully meet all code requirements and requirements of the Inspector and Authority Having Jurisdiction (AHJ)
E. The inspection process for data telecommunications is the same as any other inspection by the State of Michigan.
   1. Do not cover or conceal any wiring without approval.
   2. Electrical Inspectors will be conducting the inspections.
   3. Contractor shall be responsible for scheduling the inspections and attending the inspections with the inspector
F. The inspectors will be inspecting for code compliance including manufacture’s installation instructions for the cables and terminations.
G. An installation may not pass inspection if there is any Non-compliance with the code.

1.05 REFERENCE SPECIFICATIONS-CABLING
A. All work applicable shall conform to the following standards:
   B. ANSI/TIA-568-C.0, “Generic Telecommunications Cabling for Customer Premises”,
   C. ANSI/TIA-568-C.1, “Commercial Building Telecommunications Cabling Standard”,

COMMUNICATIONS OVERVIEW 28 10 00 - 2
F. ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces

G. IA-606-B: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings including all Updates and Addenda.

H. TIA-607-C: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

I. EIA-472 General Specification for Fiber Optic Cable

J. EIA-472A Sectional Specification for Fiber Optic Communication Cables for Outside Aerial

K. EIA-472B Sectional Specification for Fiber Optic Communication Cables for Underground and Buried Use

L. EIA-472C Sectional Specification for Fiber Optic Communication Cables for Indoor Use

M. EIA-472D Sectional Specification for Fiber Optic Communication Cables for Outside Telephone Plant Use

N. NEC, 2015, or latest edition available

O. IEEE 802.3af PoE • Ratified in 2003 • 15.4W at the PSE, with min of 12.95W available to the PD

P. IEEE 802.3at PoE+ • Ratified in 2009 • 34.2W at the PSE, with min of 25.5W available to the PD

Q. IEEE 802.3bt-2018 - IEEE Standard for Ethernet Amendment 2: Physical Layer and Management Parameters for Power over Ethernet over 4 pairs

1.06 REFERENCE STANDARDS NETWORKING

A. EE 802.3™: Ethernet

B. IEEE 802.11™: Wireless Lans

C. IEEE 802.22™: Wireless Regional Area Networks


E. IEEE 802.3af PoE • Ratified in 2003 • 15.4W at the PSE, with min of 12.95W available to the PD

F. IEEE 802.3at PoE+ • Ratified in 2009 • 34.2W at the PSE, with min of 25.5W available to the PD


1.07 CONTRACTOR-ALL

A. Each contractor shall be responsible for inspecting their own work and ensuring it meets the project requirements.

B. Contractor shall have a project manager who will be responsible for all work, workers, equipment, cabling and project management for their work. The project manager shall have the authority to make decisions for the contractor and schedule all workers.

C. Contractor shall attend all project meetings throughout the project.

D. All work on the project shall meet all applicable state, federal, local and industry codes and be installed according to the requirements of the Authority Having Jurisdiction (AHJ).

1.08 CONTRACTOR –SECURITY

A. The Contractor shall show proof of an existing contractual relationship with the approved equipment manufacturer of the video security system and access control system and shall pass through the manufacturer's certification to purchaser.

B. All hardware shall be sourced from the certifying manufacturer to assure quality control and validity of the manufacturer's warranty.

C. The Contractor shall accept complete responsibility for the installation, certification, and support of the security system. Contractor must show proof that he has the certifying manufacturer's support on all of these issues.
D. All work shall be performed and supervised by security technicians and project managers who are qualified to install security systems, and to perform related tests as required by the manufacturer in accordance with the manufacturer's methods.

E. The security technicians employed shall be fully trained and qualified by the manufacturer on the installation and testing of the equipment to be installed. Evidence that the vendor is a current certified installer of the manufacturer must be provided in writing prior to work commencing on the video security system.

F. The Contractor (including Subcontractor(s) if any) shall have a proven track record in security projects. This must be shown by the inclusion of details of at least 3 projects similar in scope and requirements which have been completed by the vendor in the last 2 years. Names, addresses, and phone numbers of references for the 3 projects shall be included.

PART 2 - PRODUCTS

2.01 FIRESTOPPING

A. Each contractor shall be responsible for firestopping around their cables and the raceways.

B. Shall be completed inside and around all conduits after cable installation.

C. Firestop for the area between the cable and the edge of the conduit shall be Nelson No. FSP, CLK or LBS+. Contractor shall install the best firestop for each individual installation.
   1. Firestop shall be installed with regard to local and national building codes.
   2. The firestop shall be a putty like substance that expands under heat and will not allow flame to pass for a designated period of time.
   3. Firestop shall conform to all NEC, NFPA, and UL requirements.
   4. Some wall pass-thru’s are shown on the drawings. The Contractor shall utilize these where possible.
   5. Where the contractor must install cables through a wall where there is no pass-thru already provided, the Contractor shall be responsible for installing a fire-rated pass-thru and fire-stopping the conduit after cable installation.

D. Firestopping is required at all riser conduits and all pass thru’s.
   1. Each cable tray penetration of a wall shall be firestopped after cable installation. Use pillow type firestop to allow additional cables to be installed in the future.
   2. Where riser conduits pass through floors, the area between the concrete and the conduit shall be firestopped. This shall be completed with a putty or liquid firestop product. Fill in the space with mineral wool, and then install the firestop on top. All firestop shall be of sufficient thickness to secure the rating required by code.
   3. After final cable installation, install a putty firestop around all cables where they enter and exit conduit pass thru’s and conduit risers.
   4. All firestop shall be installed to provide the fire rating as described by local fire code.
   5. It shall be the responsibility of the Contractor to verify that all conduits, walls, and raceways required to be firestopped have been firestopped.

E. Contractor shall provide a label at each penetration and firestop location detailing the UL rated fireproofing solution that was used in the specific application.
   1. Apply sticker to the wall near the firestopped conduit.
   2. Provide a sample of the label to the designer for review as part of the submittals.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Contractor shall be familiar with the location(s) where the work will be done. No additional compensation will be made for items the Contractor claims he was not aware of during bidding.

B. Work Area:
COMMUNICATIONS OVERVIEW

1. All work areas shall be cleaned at the end of each day. All debris shall be cleaned and removed from the site and disposed of in the approved container for the site.
2. All equipment shall be moved out of common areas and stored in the Contractor's lay down area, or in other approved storage locations on site.
3. Any work that is low hanging or may otherwise impede the general use of the space, and cannot be removed, shall be flagged and cordoned off by the Contractor.

C. All equipment and parts shall be installed in a neat and workmanlike manner. Good installation principles shall be used throughout the project.

D. All cables routed above the drop ceiling or in the ceiling area shall be installed square to the building. Diagonal cable runs are not permissible.

E. All cut edges of conduits, boxes, raceway, etc., shall be trimmed and filed so that no burrs or rough edges will damage cable as it is installed.

F. All surface raceways, including conduits in exposed areas shall be painted to match the existing colors of the surrounding area.

G. If, in the course of the work, the Contractor damages, marks, or misplaces any ceiling tiles, the Contractor shall repair, and/or replace the ceiling tile to the original condition.

1. The Engineer shall decide if ceiling tiles have been damaged. Based on the Contractors proposed fixes, the Engineer shall decide the best course of action to repair any damage done by the Contractor to the ceiling tiles.

H. It shall be the responsibility of the Contractor to repair any damage done to the structure or finishes in the building by the Contractor. The building shall be returned to its original condition prior to final sign off of the project.

I. Firestop shall be installed to meet national and local codes.

3.02 DOCUMENTS

A. The Contractor shall fully read the contract documents including the detailed specifications, and the detailed drawings.

B. No additional compensation shall be made for any portion of the project which the Contractor did not know of or understand prior to providing the bid response.

C. In the case of any discrepancies between the detailed drawings and the detailed specifications, the Contractor shall provide the higher quality or more stringent requirement.

3.03 WORK PLAN-POST BID (CHOSEN CONTRACTOR ONLY)

A. Along with the submittals the Contractor shall provide a work plan for the implementation of the telephone switch and data/wireless network. The plan shall include scheduled dates for major milestones, and all phases required for completion prior to final cutover.

B. The work plan shall list all items that must be completed by the Contractor or Owner to provide a smooth install of the telephone system and data network. The Contractor shall be responsible for all costs associated with the planning and cutover. The Owners only responsibility is to act as a liaison between the Contractor and the users.

C. The work plans shall include a timeline and a cutover date for the systems within each building. Contractor shall be responsible for all aspects of scheduling the work, including notification of the users, the administration, and the telephone service provider.

D. The work shall commence within 10 days of award of the contract. The Contractor shall be responsible for attending weekly project meetings at the Owner's site to report on progress and keep the project team informed of the work being done.

E. The work plan will be reviewed at each weekly meeting for compliance and updates.

F. Work shall immediately begin on site surveys to determine the existing infrastructure and determining placement of new system electronics. The Contractor shall be responsible for moving, relocating, and reconnecting any and all existing equipment required for the installation of the new systems.

G. After work plan and system approval by the Engineer the Contractor can begin work on infrastructure work that does not impede users.
H. The Contractor shall be responsible for working with the Owner’s Information Technology staff and administrators.

END OF SECTION 28 10 00
SECTION 283111
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

A. All air-sampling ports installed in decorative and finished ceilings shall be installed discrete and co-
ordinated with architecture for final finish color. Coordinate with architectural reflected ceiling plan
prior to installation. Contact the architect of design where discrepancies and/or conflicts occur with
ceiling finishes, décor and other discipline construction documents.

B. All air-sampling network piping in open ceiling gallery spaces shall be routed in-line with structural
ceiling joists, hidden from view when possible, and be painted to match surrounding finish. Piping
network shall be effectively labeled in accordance with NFPA-72, Chapter 17. Coordinate with ar-
chitectural reflected ceiling plan prior to installation. Contact the architect of design where discrep-
ancies and/or conflicts occur with ceiling finishes, décor and other discipline construction documents.

C. Air-sampling network piping route and sampling port locations shall be included as part of the shop
drawing package and submitted to the electrical engineer of design as well as the architect of de-
sign. Refer to section 1.5 ACTION SUBMITTALS for all shop drawing requirements.

D. All concealable notification devices installed in decorative and finished ceilings shall be coordinated
with architecture for final finish color. Coordinate with architectural reflected ceiling plan prior to in-
stallation. Contact the architect of design where discrepancies and/or conflicts occur with ceiling
finishes, décor and other discipline construction documents. Concealable notification device prod-
uct data and shop drawings shall be submitted to the electrical engineer of design as well as the
architect of design. Refer to section 1.5 ACTION SUBMITTALS for all shop drawing requirements.

1.2 PROJECT SUMMARY

A. Provide a new microprocessor controlled, intelligent reporting fire alarm system serving the new ad-
dition to the Hilberry Theatre, as shown on the drawings and specified herein. The system shall in-
clude, but not be limited to, alarm initiating devices, alarm notification appliances for live and pre-
recorded evacuation instructions, Network Fire Alarm Control Panels (FACP), Network Reporting
Nodes, Network Liquid Crystal Displays, auxiliary control devices, remote power supplies, remote
annunciators, emergency voice/alarm communication equipment, and wiring. All fire alarm equip-
ment shall be provided to form a complete, U.L. listed, coordinated system, ready for operation.

B. Control Equipment:

1. The Fire Alarm Control Panel (FACP) that is programmed to monitor and control all of the build-
ing fire alarm devices and emergency voice control equipment, and a Fire Alarm Network Re-
porting terminal shall be located in the Security Control/Monitoring Room 01.315.
   a. The Fire Alarm Contractor shall provide all firmware and software as required to establish a
      fully functional monitoring and control interface to the Fire Alarm Network Reporting Termi-
nal. All interface equipment provisions, equipment connections, software integration,
      equipment support, and site coordination shall be the responsibility of the Fire Alarm Con-
tractor.

2. Alarm acknowledging, alarm silencing and system resetting shall be accomplished only from
   the main building FACP or Network Reporting Terminal in the Fire Command Room. The sys-
tem shall only be reset by factory trained and authorized personnel for the installed system.
   These three (3) functions shall be password protected.
C. System Supervision: The system shall be electrically supervised and monitor the integrity of all conductors. Each designated initiating point shall simultaneously transmit separate and distinct alarm, supervisory and trouble signals to the fire alarm network.

D. System Monitoring: Provide a digital communicator to connect to Owner provided telephone circuits. Provide 3 output zones, (1) sprinkler waterflow, (2) supervisory signal, (3) alarm other than waterflow.

E. System Wiring Connections: The system shall be a proprietary, low voltage, closed circuit, electrically supervised, non-coded, continuous sounding type as described in NFPA 72. Circuit type and supervision shall be Class A for the fire alarm network connections, Class A for Signaling Line Circuits (SLC’s) from the control panels to the initiation devices, and Class A for the Notification Appliance Circuits (NAC’s).

F. Audible Alarm Indication:
   1. The system shall include a multiplexed emergency voice alarm communication system utilizing distributed amplification and intelligence such that loss of operation by the main emergency control panel will not result in the loss of evacuation signal throughout the balance of the building. Provide remote amplifiers distributed throughout the building as indicated on the construction documents. Connect the speakers on each level to their respective floor amplifier. Provide 25% spare wattage capacity in every amplifier. Provide a distributed standby amplifier for every five (5) primary operating amplifiers. The system shall feature automatic switchover to a standby amplifier in the event of any primary amplifier failure. Amplifiers shall feature volume controls, concealed behind locking or screw-on covers. Amplifiers shall be current limited and constantly monitored.
   2. Pre-recorded messages shall originate from a solid state storage device. Failure of the message system shall result in automatic takeover by alarm tone signal. Voice system will be single channel in design. Provide pre-recorded messages for fire and other public safety messages. Coordinate exact pre-recorded messages with the Owner prior to programming of the system.
   3. The digitized voice messages shall be recorded exclusively for the building per the Owner’s requirements, and shall be factory recorded utilizing a female voice. All messages will be custom programmed to match the building owner’s requirements. The message shall notify building occupants that a fire condition has been detected or alert of other public safety warnings. The message will automatically identify the specific floor location from which the alarm originated. Generalized alarm messages, which do not specifically identify the alarm floor location within the text of the message, are not acceptable.
   4. Emergency manual voice override shall be provided in the main building FACP.
   5. Provide emergency one-way paging capability in the main building FACP. The system shall feature dual microphone preamplifiers and spare power amplifiers for redundancy. The system shall include a hand held type microphone with push-to-talk switch. The microphone cable shall be permanently connected to the control panel. Operation of the system microphone push-to-talk switch shall pre-empt any alarm tone or pre-recorded message in the selected communication zone. System pre-amplifier shall be supervised. Any pre-amplifier failure shall automatically cause a standby pre-amplifier to be substituted and cause a trouble indication on the main control panel.
   6. The amplifier monitoring system shall consist of any UL listed method that does not result in an audible output in the system speakers, but will cause a trouble signal upon detection of any failure which would interfere with amplification and reproduction of alarm tones and evacuation messages. Detection of an amplifier failure shall automatically cause substitution of a standby amplifier and shall activate the trouble indicator and audible signal at the fire alarm network.
   7. Audible notification system Speaker units shall be white in color.

G. Visual Alarm Indication: Complete building visual xenon-strobe type units to provide a synchronized flash rate. The strobe units will conform to the light intensities as indicated on the drawings.
1. Visual notification system strobe units shall be white in color.

H. Interface to other Sections: The fire alarm system contractor shall be responsible for coordination with all Division 21, 22, and 23 contractors for fire protection and suppression system interfaces, as well as the required interface between the fire alarm system and the Building Management System (BMS). This coordination shall include, as a minimum deluge suppression systems, and all other fire protection systems (wet and dry sprinkler systems). The contractor shall provide all necessary devices, wiring, etc.

I. Fire Protection Systems:

1. The system shall monitor the status of the building wet and dry sprinkler fire protection systems. Three levels of monitoring shall be provided:
   a. Alarm: activated when a water flow condition is detected.
   b. Supervisory: activated when a gate valve is closed indicating a tamper switch is activated.
   c. Supervisory: activated when an off - normal system air pressure signal is detected.
   d. Trouble - activated when a short, open, or other fault is detected on the initiation circuit.

J. The system shall control the fire protection sprinkler system exterior horn/strobe. Activation of water flow indicating switch shall automatically activate the exterior horn/strobe. The horn/strobe shall be connected to a non-silenceable circuit so that anytime a water flow condition is detected, the horn/strobe will operate regardless of the status of the fire alarm system. All wiring shall be supervised and the horn/strobe shall operate on 24 VDC power from the fire alarm system.

K. Interface to the Building Management and Control System:

1. The fire alarm system shall include dry contact interfaces to the building BMS System equipment for control and indication of HVAC fan shutdown and damper control and monitoring.

L. Fan Shutdown: The system shall automatically shut down HVAC systems if smoke is detected in the main supply or return ducts of the unit. Duct mounted smoke detectors shall transmit a supervisory signal to the fire alarm network. The network shall then activate an addressable control module that shall interface to the fan control circuit.

M. Security System Interface: The system shall include the following interfaces to the building access control/security system:

1. Automatic Door Closure
   a. Provide programmable monitoring modules to interface to the security system for automatic release of magnetic door holders. Provide one (1) monitoring input per building floor per occupancy separation. The security system shall initiate a signal for door holder release. The fire alarm system shall monitor this signal via monitoring modules, and shall activate the appropriate fire alarm control module(s), which are connected to door holder power circuits.
   b. The fire alarm system shall include dry contact interfaces to the building Access Control System for unlocking of doors and with the 120V auto operators for opening of doors and monitoring door position per the smoke control sequence as described in specification section 230993.

2. Automatic Unlock of Electric Locking Mechanisms
   a. Interface requirements to provide automatic unlocking of electric locking mechanisms controlled by the security system, upon a fire alarm condition as required by applicable codes and the local Authority Having Jurisdiction (AHJ).

3. Monitoring of Fire Alarm Manual Unlock Switch
   a. Interface requirements to provide monitoring of the fire alarm system manual unlock switch for electric locking mechanisms control by the security system, as required by applicable codes and the local Authority Having Jurisdiction (AJH).

4. Auxiliary Monitoring of Fire Alarm and Trouble Conditions
a. Interface requirements to provide auxiliary monitoring of the fire alarm system general alarm and trouble conditions by the security system.

5. System Interface
a. In order to provide the fire alarm/security system interface, the Fire Alarm System Contractor shall provide interface cabinets at each location as indicated below. Each interface cabinet shall contain all terminals required to interface each associated point to the security system as specified herein.

<table>
<thead>
<tr>
<th>Location</th>
<th>Interface Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security Equipment Closets</td>
<td>Automatic Unlock</td>
</tr>
<tr>
<td>Fire Command Center</td>
<td>Manual Unlock</td>
</tr>
<tr>
<td></td>
<td>Manual Unlock Switch Position</td>
</tr>
<tr>
<td></td>
<td>Auxiliary Monitoring (Alarm and Trouble)</td>
</tr>
</tbody>
</table>

6. Fire Alarm Interface Cabinet
a. The fire alarm contractor shall provide lockable continuous hinge cover, U.L. listed enclosures with dual-screw barrier terminal strips for each interface point as indicated on the Security Drawings. All terminals shall be labeled to identify their function.
b. The Architect, prior to installation, shall approve the exact style and finish of each enclosure.
c. Each fire alarm interface cabinet shall provide a tamper switch to be monitored by the security system, and shall be keyed as defined by the Architect.

7. Automatic Unlock of Electric Locking Mechanisms
a. The fire alarm contractor shall provide normally closed auxiliary dry output contacts such that upon a general fire alarm condition, the contacts shall open and the security system shall unlock the electric locking mechanism. The contacts shall remain open until the fire alarm system in manually reset.

8. Monitoring of the Manual Unlock Switch
a. The fire alarm contractor shall provide a normally closed, auxiliary dry output contact for security monitoring of the position status of the fire alarm manual unlock switch. The contact shall open when the switch is placed in the unlock position and shall remain open until the switch is returned to the locked position.
b. The fire alarm contractor shall provide any hardware/software required to interface the fire alarm manual unlock switch to the security system.
c. The fire alarm contractor shall provide and terminate all conduit, power and wiring required for the monitoring of the manual unlock switch.

9. Auxiliary Monitoring of Fire Alarm and Trouble Conditions
a. The fire alarm contractor shall provide separate normally closed, auxiliary dry output contacts for general alarm and general trouble conditions. Upon an alarm and/or trouble condition the contact shall open and the security system shall annunciate the associated condition. The contacts shall remain open until the fire alarm system in manually reset.

10. Fire Alarm Interface Cabinet
a. The fire alarm contractor shall provide interface cabinets in readily accessible, concealed locations, no more than 8'0" A.F.F. Coordinate the exact location of the interface cabinet location with the Architect.
b. The fire alarm contractor shall provide any hardware/software, control logic, and/or relays required to interface the fire alarm system to the security system as specified herein.
c. The fire alarm contractor shall provide and terminate all conduit, power, and wiring required for the installation of each interface cabinet.
a. The fire alarm contractor shall provide one (1) spare pair of wires, for future use,
d. The Security Contractor shall provide and terminate all wiring from the interface cabinet to the security system.
e. All wiring shall be U.L. listed for fire alarm applications.
1.3 SUMMARY

A. Section Includes:
   1. Fire-alarm control panel.
   3. System smoke detectors.
   4. Air-sampling smoke detectors.
   5. Heat detectors.
   7. Device guards.
  10. Graphic annunciator.
  11. Addressable interface device.
  12. Digital alarm communicator transmitter.

B. Project Summary

C. System Spare Capacity
   1. Provide spare capacity for fire alarm circuits as required below.
      b. Amplifier Circuits: 25% spare capacity for each circuit installed.
      c. Signaling Line Circuits (SLC): 25% spare capacity for each circuit installed.

D. Related Requirements:
   1. Section 087100 “Door Hardware”
   2. Section 211313 “Wet-Pipe Sprinkler Systems”
   3. Section 230993 “Sequence of Operation for HVAC Controls”
   4. Section 237316 “Air-Handling Units”
   5. Section 280500 “Common Work Results for Electronic Safety and Security”
   6. Section 280513 “Conductors and Cables for Electronic Safety and Security”
   7. Section 260526 “Grounding and Bonding for Electrical Systems”
   8. Section 260533 “Raceways and Boxes for Electrical Systems”
   9. Section 260544 “Sleeves and Sleeve Seals for Electrical Raceways and Cabling”

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.
   1. Include construction details, material descriptions, dimensions, profiles, and finishes.
   2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.
   1. Provide coversheet indicating project title, project location, and vendor contact information.
   2. Organize submittal into logical sections and provide table of contents.
   3. Provide itemized bill of materials indicating model number and quantity for each product.
   4. On datasheets with multiple products, indicate which product is provided under this project.
   5. Combine electronic submittals into one unified PDF document that is organized per the table of contents. The submittal shall be free of copyrighted files and proprietary file formats. Electronic links may be submitted to supplement product datasheets, but may not be used as a substitute for product datasheets that are required to be included in the unified PDF submittal.
   6. Manufacturers’ catalog sheets with complete technical data for each item being furnished.
   7. Comply with recommendations and requirements in the “Documentation” section of the “Fundamentals” chapter in NFPA 72.
   8. Include plans, elevations, sections, details, and attachments to other work.
9. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.

10. Detail assembly and support requirements.

11. Include voltage drop calculations for notification-appliance circuits.

12. Include battery-size calculations.

13. Include input/output matrix.

14. Settings for occupant notification
   a. Include wattage taps and decibel (dB) ratings at each speaker and speaker/strobe device.

15. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.

16. Include performance parameters and installation details for each detector.

17. Include performance parameters and installation details for all each surge suppression module.

18. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

19. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.

20. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
   a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
   b. Show field wiring required for HVAC unit shutdown on alarm.
   c. Locate detectors according to manufacturer’s written recommendations.
   d. Show air-sampling detector pipe routing.

21. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

22. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.

2. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified, fire-alarm technician; Level III minimum, Level IV preferred.
   c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.

2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.

3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.
1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
   1. Include the following and deliver copies to authorities having jurisdiction:
      a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
      b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
      c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
      d. Riser diagram.
      e. Device addresses.
      f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
      g. Record copy of site-specific software.
      h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
         1) Equipment tested.
         2) Frequency of testing of installed components.
         3) Frequency of inspection of installed components.
         4) Requirements and recommendations related to results of maintenance.
         5) Manufacturer's user training manuals.
      i. Manufacturer's required maintenance related to system warranty requirements.
      j. Abbreviated operating instructions for mounting at fire-alarm control panel and each annunciator panel.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
   2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
   3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
   4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
   5. Keys and Tools: One extra set for access to locked or tamper-proofed components.
   6. Audible and Visual Notification Appliances: One of each type installed.
   7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
   8. Surge Protection devices: 2 of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
1.8 QUALITY ASSURANCE
A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.9 PROJECT CONDITIONS
A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.10 WARRANTY
A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
   1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
   2. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
A. Provide a new non-coded, intelligent, addressable system, with multiplexed signal transmission and voice/strobe evacuation.
B. Automatic sensitivity control of certain smoke detectors.
C. All components provided shall be listed for use with the selected system.
D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION
A. Fire Alarm Systems Operation Matrix
### Initiating Device

<table>
<thead>
<tr>
<th>Initiating Device</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>M</th>
<th>N</th>
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<tbody>
<tr>
<td>Spot type smoke detector</td>
<td>X₁</td>
<td>X₁</td>
<td>X₁</td>
<td>X₁</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Spot type heat detector</td>
<td>X₁</td>
<td>X₁</td>
<td>X₁</td>
<td>X₁</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Spot type smoke detector at elevator lobby and/or elevator equipment rooms</td>
<td>X₁</td>
<td>X₁</td>
<td>X₁</td>
<td>X₁</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Heat detector – elevator equipment room or elevator pit</td>
<td>X₁</td>
<td>X₁</td>
<td>X₁</td>
<td>X₁</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Smoke detector for door release function</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X</td>
<td>X</td>
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<td>Duct smoke detector – mechanical equipment fan</td>
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<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X</td>
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<td>X</td>
<td>X</td>
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<tr>
<td>Duct smoke detector – damper</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Div. 21 wet sprinkler water flow switches</td>
<td>X₁</td>
<td>X₁</td>
<td>X₁</td>
<td>X₁</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>Div. 21 sprinkler valve tamper</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
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<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Post indicator valve (PIV) tamper switch</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Air-sampling smoke detector panel output – pre-alarm</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Air-sampling smoke detector panel output – alarm</td>
<td>X₁</td>
<td>X₁</td>
<td>X₁</td>
<td>X₁</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>Control panel ac power loss</td>
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<td>X₃</td>
<td>X₃</td>
<td>X₃</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Class “A” network wire fault</td>
<td>X₃</td>
<td>X₃</td>
<td>X₃</td>
<td>X₃</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>Communication fault digital communicator</td>
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<td>X₃</td>
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<td>Fire alarm battery or charger failure</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>User disabling of zones or individual devices</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Open circuits, shorts, and grounds in designated circuits</td>
<td>X₃</td>
<td>X₃</td>
<td>X₃</td>
<td>X₃</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
<tr>
<td>Opening, tampering with, or removing alarm-initiating and supervisory signal</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
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<td>Supervisory signal-initiating devices</td>
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<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
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<td>X</td>
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<td>X</td>
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<tr>
<td>Loss of communication with any addressable device</td>
<td>X₃</td>
<td>X₃</td>
<td>X₃</td>
<td>X₃</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ground or a single break in internal circuits of fire-alarm control panel</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Abnormal ac voltage at fire-alarm control panel</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Break in standby battery circuitry</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X₂</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Abnormal position of any switch at fire-alarm control panel or annunciator</td>
<td>X₃</td>
<td>X₃</td>
<td>X₃</td>
<td>X₃</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
</tr>
<tr>
<td>Common alarm signal</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Common supervisory signal</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Common trouble signal</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

### TYPE of SIGNAL

- **X₁** = Alarm Signal
- **X₂** = Common supervisory signal
- **X₃** = Common trouble signal
- _ = Action not required.

### SYSTEM OPERATION

- **A** = Annunciate specific device at FACP and remote annunciators FAAP.
- **B** = Annunciate specific device at graphic video terminals on Fire Alarm Network
- **C** = Transmit to Central Station/Monitoring.
- **D** = Activate notification appliances as described in specification.
- **E** = Activate relay to close damper.
- **F** = Activate relay to shutdown AHU/MAU fan, unless specifically noted otherwise.
- **G** = Activate Exterior Bell/Horn/Strobe.
- **I** = Release all the hold open smoke doors indicated on the drawings.
- **J** = Recall elevator in designated bank.
- **K** = Transmit status to elevator controller
M = Transmit status to access control panel, refer to 281300 for access control system protocol
N = Record events in system memory

MATRIX GENERAL NOTES:

*After a time delay of 200 seconds, transmit trouble or supervisory signal to the remote alarm receiving station.

** Where a paging system is provided shall cease/mute operation during notification appliance activation and reset to normal when the fire alarm system is reset to normal.

2.3 FIRE-ALARM CONTROL PANEL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Notifier. Inc, a Honeywell company
   3. SimplexGrinnell LP.

B. General Requirements for Fire-Alarm Control Unit:
   1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
      a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
      b. Include a real-time clock for time annotation of events on the event recorder and printer.
      c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
      d. The FACP shall be listed for connection to a central-station signaling system service.
      e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
   2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
   3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control panel and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
   1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
   2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

D. Initiating-Device, Notification-Apppliance, and Signaling-Line Circuits:
   1. Pathway Class Designations: NFPA 72, Class A.
   3. Install no more than 256 addressable devices on each signaling-line circuit.
   4. Serial Interfaces:
      a. One dedicated RS 485 port for central-station operation using point ID DACT.
      b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
      c. One USB or RS 232 port for PC configuration.
d. One RS 232 port for VESDA HLI connection.
e. One RS 232 port for voice evacuation interface.

E. Notification-Appliance Circuit:
1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

F. Elevator Recall:
1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
   a. Elevator lobby detectors except the lobby detector on the designated floor.
   b. Smoke detector in elevator machine room.
   c. Smoke detectors in elevator hoistway.
2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
   a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

J. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet located in the fire command center.
1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
   a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
   b. Programmable tone and message sequence selection.
   c. Standard digitally recorded messages for "Evacuation" and "All Clear."
   d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control panel.
2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Notifier. Inc., a Honeywell company
      3. SimplexGrinnell LP.
   B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer’s surface back box.
      1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control panel.
      2. Station Reset: Key- or wrench-operated switch.
      3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
      4. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Notifier. Inc., a Honeywell company
      3. SimplexGrinnell LP.
   B. General Requirements for System Smoke Detectors:
      1. Comply with UL 268; operating at 24-V dc, nominal.
      2. Detectors shall be two-wire type.
      3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.
      4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
      5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
      6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
      7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control panel for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control panel.
         a. Multiple levels of detection sensitivity for each sensor.
         b. Sensitivity levels based on time of day.
C. Photoelectric Smoke Detectors:
   1. Detector address shall be accessible from fire-alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control panel, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).

D. Ionization Smoke Detector:
   1. Performance Criteria:
      a. Regulatory Requirements:
         1) NFPA 72.
         2) UL 268.
      b. General Characteristics:
         1) Detectors must be two-wire type.
         2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
         3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
         4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
         5) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
         6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
         7) Operator at FACU, having designated access level, must be able to manually access the following for each detector:
            (a) Primary status.
            (b) Device type.
            (c) Present average value.
            (d) Present sensitivity selected.
            (e) Sensor range (normal, dirty, etc.).
         8) Detector must have functional humidity range within 10 to 90 percent relative humidity.
         9) Color: White.
      10) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACU.
      11) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for 15 or 20 deg F (8 or 11 deg C) per minute.
      12) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at 135 or 155 deg F (57 or 68 deg C).
      13) Multiple levels of detection sensitivity for each sensor.
      14) Sensitivity levels based on time of day.

E. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
   1. Detector address shall be accessible from fire-alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control panel, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

2.6 HEAT DETECTORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Notifier. Inc., a Honeywell company
   3. SimplexGrinnell LP.
B. General Requirements for Heat Detectors: Comply with UL 521.
   1. Temperature sensors shall test for and communicate the sensitivity range of the device.
C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.
   3. Control Unit: Two-zone or multizone unit as indicated. Provide same system power supply, supervision, and alarm features as specified for fire-alarm control panel.
   4. Signals to Fire-Alarm Control Unit: Any type of local system trouble shall be reported to fire-alarm control panel as a composite "trouble" signal. Alarms on each detection zone shall be individually reported to central fire-alarm control panel as separately identified zones.
   5. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.

2.7 NOTIFICATION APPLIANCES
A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Cooper Wheelock.
   2. Notifier.
   4. SimplexGrinnell LP.
B. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.
C. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear polycarbonate lens mounted on an white (UNO) faceplate. The word “FIRE” is raised lettering or engraved in minimum 1-inch- (25-mm-) high letters on the faceplate, below or on side of the lens.
   1. Mounting: Wall mounted unless otherwise indicated.
   2. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   3. Flashing shall be in a temporal pattern, synchronized with other units.
   5. Mounting Faceplate: Factory finished white.

E. Voice/Tone Notification Appliances:
   1. Comply with UL 1480.
   2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the “Notification Appliances” and “Emergency Communications Systems” chapters in NFPA 72 and Annex D.
   3. High-Range Units: Rated 2 to 15 W.
   4. Low-Range Units: Rated 1 to 2 W.
   5. Frequency Range: 300Hz to 8000Hz.
   7. Matching Transformers: Tap range matched to acoustical environment of speaker location.

F. Concealable Notification Devices:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Concealite #FA100 #FAFX
      b. Pre-Approved Equivalent
   2. Provide concealable notification devices as indicated on floor plans with device cover to match ceiling finish. Concealment device shall be UL listed for the application and shall conform to NFPA 72 standards. Concealment device shall be self-contained and shall interface with the fire alarm system. Provide fire-alarm system notification device that is compatible with the fire alarm system and concealment device system and has a similar appearance to the building notification appliances.

2.8 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES
A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.9 MAGNETIC DOOR HOLDERS
A. Connection: Provide connection to the fire-alarm system door holders provided under Division 08. Coordinate location, rough-in requirements, and voltage with hardware supplier.
B. Provide a local switch for hold open release.
C. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
   1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
   2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
   3. Rating: 120-V ac.
D. Material and Finish: Match door hardware.
E. Provide a local switch for hold open open release.

2.10 REMOTE ANNUNCIATOR
A. Description: Annunciator functions shall match those of fire-alarm control panel for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control panel, including acknowledging, silencing, resetting, and testing.
   1. Mounting: Flush cabinet, NEMA 250, Type 1.
B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control panel. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.11 ADDRESSABLE INTERFACE DEVICE
A. General:
   1. Include address-setting means on the module.
   2. Store an internal identifying code for control panel use to identify the module type.
   3. Listed for controlling HVAC fan motor controllers.
B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall.
   1. Allow the control panel to switch the relay contacts on command.
   2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
D. AHU shutdown relays shall be provided where air handler shutdown is required. The shutdown relay shall be controlled by either a supervised NAC circuit, independently controlled programmable supervised duct detector output circuit, or I/O point circuit. The shutdown relay shall not be controlled by an electronic control module. Each shutdown relay shall have two sets of form C contacts, the first set to be used for the shutdown signal and the second set used for notification to the building automation system.
E. Control Module:
   1. Operate notification devices.
   2. Operate solenoids for use in sprinkler service.

2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER
A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 864.
B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control panel and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
C. Local functions and display at the digital alarm communicator transmitter shall include the following:
   1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
5. Communications failure with the central station or fire-alarm control panel.

D. Digital data transmission shall include the following:
1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.13 EXTERIOR DEVICE SURGE PROTECTOR
A. Provide surge protection for exterior/outdoor initiating and notification devices.
B. SLC and NAC surge protectors shall have 10AWG max screw terminals.
C. Minimum Specifications:
   1. Service Voltage: 48V
   2. Maximum Continuous Operational Voltage: 64V
   3. Clamping Voltage: 76V
   4. Peak Surge Current: 20000A
   5. Operating Temperature: -40 degrees F to 158 degrees F
   6. UL Listed: UL497B
D. Manufacturer Warranty: 10 Years
E. Manufacturer: Ditek #DTK-2MHLP or pre-approved equivalent

2.14 DIALER SURGE PROTECTOR
A. Provide fire-alarm dialer (DACT) surge protection for both primary and secondary communications with central station monitoring.
B. Dialer surge protector shall have 10AWG max screw terminals.
C. Minimum Specifications:
   1. Service Voltage: 110V
   2. Maximum Continuous Operational Voltage: 130V
   3. Clamping Voltage: 200V
   4. Peak Surge Current: 14000A @ 8/2000us impulse
   5. Operating Temperature: -40 degrees F to 158 degrees F
   6. UL Listed: UL497B
D. Manufacturer Warranty: 10 Years
E. Manufacturer: Ditek #DTK-2MHTP or pre-approved equivalent

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2.15  120V FIRE-ALARM CONTROL PANEL SURGE PROTECTOR

A. Provide fire-alarm control panel 120V surge protection between the FACP and branch-circuit over-current protection device. Coordinate with division 26 for installation.

B. Minimum Specifications:
   1. Service Voltage: 120V
   2. Maximum Continuous Operational Voltage: 130V
   3. Protection Modes: L-N, L-G, N-G
   4. Peak Surge Current: 18000A
   5. Operating Temperature: -40 degrees F to 185 degrees F
   6. UL Listed: UL1449 3rd Edition

C. Manufacturer Warranty: 10 Years

D. Manufacturer: Ditek #120 Series or pre-approved equivalent

2.16  SECONDARY POWER SUPPLIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   1. Honeywell Power Supplies
   2. Altronix Power Supplies
   3. Life Safety Power

B. Standby power supply shall be an electrical battery with capacity to operate the system under maximum supervisory load for 24-hours and capable of operating the system for fifteen 15-minutes of evacuation alarm on all devices, operating at maximum load.

C. The system shall include a charging circuit to automatically maintain the electrical charge of the battery and supervise the integrity of the battery. The system shall automatically adjust the charging rate of the battery to compensate for temperature.

D. All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.

E. Secondary power supplies shall also meet the minimum specifications:
   1. The power supply shall meet or exceed the following specifications:
      a. The design shall consist of grey or red steel wall-mount housing with a locking door.
      b. The power supply shall provide with isolated 24 VAC outputs.
      c. The power supply shall provide resettable fuses for each output.
      d. PTC protected outputs shall meet Class 2, power limited, requirements.
      e. Notification Appliance Circuit (NAC) power extenders shall have the capability to synchronize all strobe and audible signals in accordance with NFPA-72.
      f. All power supplies shall be electrically supervised and report a trouble signal for all fault and failure conditions.
   2. The electrical specifications for the power supply shall be as follows:
      a. Input voltage: 120 VAC
      b. Output voltage: 24 VAC
2.17 FIRE ALARM WIRING

A. Wiring Circuit Class and Style
   1. Initiating Device, Notification Appliance, and Signaling Line Circuits as defined in 2010 Edition of NFPA.
      a. Separate signaling line circuits (SLC) shall be provided for the following:
         1) Initiating Device Circuits: Class A
         2) Initiating Device Circuits for elevator recall: Class A
         3) Initiating Device Circuits for fire-protection riser: Class A
      b. Notification Appliance Circuits: Class A.
      c. Amplifier (Speaker) Circuits: Shielded, class A
      d. Class A circuit routing shall be physically separated and shall be not be run in the same cable assembly, enclosure, or raceway. Separate circuits a minimum of 2’ for vertical runs and 4’ for horizontal runs.
      e. Riser/backbone cabling between fire-alarm panels and nodes: Class A.

B. Wiring Type: Fire alarm wiring shall be red, plenum rated, and as required per system manufacturer where free air is allowed. When installed in approved raceways, use of FPL (THHN/THWN) is permitted.

PART 3 INSTALLATION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
   1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
   1. Devices placed in service before all other trades have completed cleanup shall be replaced.
   2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Equipment Mounting: Install fire-alarm control panel on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (460-mm) centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Equipment Mounting: Install fire-alarm control panel on finished floor.
D. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.

E. Manual Fire-Alarm Boxes:
   1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
   3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

F. Smoke- or Heat-Detector Spacing:
   1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
   2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
   3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
   4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
   5. HVAC: Locate detectors not closer than 36 inches (910 mm) from air-supply diffuser or return-air opening.
   6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

G. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

H. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.
   1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
   2. Duct detectors shall be installed within 5' of the HVAC unit, smoke damper or fire/smoke dampers that they are interfaced with.

I. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

J. Theatrical Spaces: Provide detection devices which are able to be utilized with theatrical fog effects without requiring any shunting of notification alarms.

K. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

L. Audible Alarm-Indicating Devices: Install wall mounted devices not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

M. Ceiling Mounted Audible/Visual and Visual Only Alarm-Indicating Devices: Install flush on ceiling in approximate location indicated. Coordinate with all ceiling mounted diffusers, lights, devices, etc. Provide concealed mounting where noted with UL listed device.
N. Concealable notification devices as indicated on floor plans with device cover to match ceiling finish as determined by architect. Coordinate with Architectural ceiling plans prior to final placement of concealable notification devices. Contact the architect of design where discrepancies and/or conflicts occur with ceiling finishes, décor and other discipline construction documents.

O. Visible Alarm-Indicating Devices: Install wall mounted devices adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

P. Device Location-Indicating Lights: Locate in public space near the device they monitor.

Q. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

R. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor

S. Provide addressable monitor modules with 120V relays for each smoke damper connection to provide individual programmed control of damper(s).

T. Provide addressable monitor modules for elevator controller to initiate elevator recall.

U. Provide addressable monitor modules for elevator circuit breaker shunt-trip for power shutdown.

V. Provide addressable monitor modules for AHU for power shutdown. The shutdown relay shall be located adjacent to the controller for the AHU.

W. Provide 2-input or 10-input addressable monitor modules when applicable.

X. Mini addressable monitor modules shall not be used without prior approval by the engineer of design.

3.3 PATHWAYS

A. Conductors and Cables above recessed ceilings and in non-accessible locations may be routed exposed.
   1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.

B. Conductors and Cables within open ceilings shall be routed in conduit to a location with an accessible ceiling.

C. Conductors and Cables shall be installed in EMT.

D. Minimum Pathway Size: 3/4-inch (21-mm) trade size.

E. Exposed EMT shall be painted to match surrounding finish.

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
   1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Smoke dampers in air ducts of designated HVAC duct systems.
2. Magnetically held-open doors.
3. Electronically locked doors and access gates.
4. Alarm-initiating connection to elevator recall system and components.
5. Supervisory connections at valve supervisory switches.
7. Data communication circuits for connection to building management system.

3.5 IDENTIFICATION
A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
B. Install framed instructions in a location visible from fire-alarm control panel.

3.6 GROUNDING
A. Ground fire-alarm control panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control panel.
B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL
A. Field tests shall be witnessed by authorities having jurisdiction.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
C. Perform tests and inspections.
D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
      b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
   3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
   4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
   5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
   6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
G. Prepare test and inspection reports.
H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE
A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months’ full maintenance by skilled employees of manufacturer’s designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer’s authorized replacement parts and supplies.
   1. Include visual inspections according to the “Visual Inspection Frequencies” table in the “Testing” paragraph of the “Inspection, Testing and Maintenance” chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT
A. Comply with UL 864.
B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
   1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES
A. This section includes parts and equipment required for installation and termination of a building-wide Access Control and intrusion detection system. This system shall be referred to as the “security system” throughout these specifications.
B. The systems is for doors noted on the drawings as “OneCard”
   1. These are primarily interior doors. The access control equipment at these doors shall be connected to the CBORD panels. See floorplans for locations.

1.02 SYSTEM DESCRIPTION
A. The security system shall be supplied and installed by a Contractor able to show examples of similar projects and installations within the last 3 years.
B. The security system shall be an extension of the existing system at the WSU Campus
C. The Security System shall provide a solution for access control systems
D. Contractor shall provide all software required for connection of the security system to the in-house data network and associated control PC’s and existing OneCard Gold server.
E. The security system client-server architecture shall communicate with native TCP/IP over an existing Ethernet TCP/IP enterprise network.

1.03 COORDINATION
A. All cables shall be coordinated with the doors and door hardware being installed as part of this project.
B. Access Control cables shall be a unique color from the Telecommunications cable, fire alarm cable and lighting control cable. Coordinate this with the Electrical Contractor prior to ordering the equipment and installation of the cables.

1.04 PROJECT PLAN
A. The contractor shall provide a project plan to the owner and contractor that describes the system and its capabilities and the possible configurations.
B. Provide a project approach which describes the installation and implementation plan and schedule and all sequencing.
C. Meet with the owner numerous times to determine how the system should work and how it should be monitored. Configure the system prior to installation to meet these requirements. Demonstrate the system use to the owner prior to installation and obtain approval to move forward with the installation.
D. Contractor shall conduct numerous site reviews to establish pathways and routes for all raceways required. Contractor shall install all raceways required for connection of the security system.
E. Provide shop drawings showing all configuration and connectivity of the system.
F. Generate a testing plan and have that plan approved by the owner and engineer prior to installing the system.
G. The system shall be installed and tested prior to cutting over any doors to the system. Provide and install temporary card readers, door contacts etc to the system for testing. Demonstrate that this works prior to cutover.

1.05 RELATED STANDARDS
A. The security system shall conform to the following international and national standards:
1. FCC Rules and Regulations
2. UL 294 Access Control Systems
3. UL 1076 Line Supervision
4. 21 CFR part 11
5. Part 15, Radio Frequency Devices
6. National Electrical Manufacturers Association (NEMA.
7. Applicable Federal, State and Local laws, regulations, codes
8. Americans with Disabilities Act (ADA.
9. National Electrical Code (NEC.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Approved vendors for security cables are:
   1. General Cable.
   2. Belden.
   3. West Penn Wire and Cable.
   4. Equivalent manufacturers.
B. Approved vendor for access control/intrusion detection equipment is:
   1. Cbord CSGold system

2.02 MATERIALS
A. All security and control cables shall be plenum rated.
   1. Contractor shall provide all appropriate cable from the door security hardware to the
      security system. All cabling shall be plenum rated.
   2. Some locations require outdoor rated cabling. The contractor shall provide the cabling
      to match the required area.
   3. There will be requirements for many different types of cabling and the contractor shall
      provide for each.
   4. Provide a coil of cable at each location for moves and maintenance.

2.03 SECURITY SYSTEM SERVER
A. Management Server:
   1. Server is existing at the owner’s data center
   2. Provide all work and any additional software from Cbord CS Gold system as required
      to connect all new devices and make then fully operate.

2.04 SECURITY SYSTEM SOFTWARE
A. Software shall be an extension of the existing campus Cbord system and shall be installed
   for the interior controlled doors and doors noted as “OneCard” on the drawings.

2.05 SECURITY ENCLOSURE
A. Shall be provided to hold power supplies, controllers, access control panels, card reader
   panels, input/output cards (now to be referred to as security panels) and any other
   components required for a complete access control system.
B. Security enclosures are the physical boxes and cabinets that support the intelligent
   controllers, I/O boards, power supplies and power distribution equipment.
C. Security panels shall be wall mounted and large enough to hold power equipment and access
   control system controllers and cards.
D. Security panel shall be:
   1. UL: Listed: UL 294 approved
   2. Enclosure shall accommodate power supply and sub-assemblies such s controllers
      and security cards to be provided as part of the project.
   3. Primary power input shall be 115VAC
   4. Physical
      a. Size enclosure as required to hold power supplies and security panels. Provide
         multiple enclosures where required.
b. Made of 16 AWG sheet metal

c. Shall have conduit knockouts or custom cut holes for access to the panels for cabling.

d. Be equipped with an internal cam lock

e. Be equipped with a tamper switch that shall be wired to the I/O for software alarm when the panel is opened.

f. Shall have space for batteries to support the access control system.

5. Equip with a backplate that shall support direct mounting of the security panels and power devices.

6. Equip with magnetic cable supports that attach to the backplate to support cables.

E. Security Enclosure shall be Altronix Trove series or equal.

2.06 POWER SUPPLIES AND POWER DISTRIBUTION

A. Power supplies and power equipment shall be provided that support the entire access control system, security panels/controllers, door locks and all other field equipment of the access control system.

B. All power supplies shall be connected to 120VAC power with a hardwired connection. Install cable and connect to power.

1. Provide and install conduit, wiring and connections required for 120-volt power connectivity.

C. Power supply shall be mounted to the enclosure. Shall include:

1. Shall provide power to the panels in the enclosure and field devices.

2. Shall include multiple 12- or 24-volt outputs. Shall be settable in

3. Input voltage of 120VAC with a fuse

4. Classified as a Power-Limited stand-alone power supply with stand-by battery and suitable to power sensors and electro-mechanical devices (e.g. electric door strikes), as defined in the National Electrical Code/NFPA70/NFPA72

5. Shall be sized for outputs of 1 thru 16 unique outputs.

6. Battery connection for charging on-board batteries.

7. Fire alarm disconnect

a. Shall support Normally Open or Normally Closed trigger

b. Shall be set to latching or non-latching

8. LED indicators for:

a. AC input

b. DC output

c. Battery discharged or no battery

9. Over Voltage protection

10. Short Circuit protection

11. Power supply shall be Altronix #eFlow series or equal.

a. Provide actual part that provides for all power and control of the system as required to meet the manufacturers requirements and these specifications.

12. Equip with an Ethernet Module for panel control and monitoring:

a. Shall support remote supervision, control and monitoring over an Ethernet connection.

b. Connect to the owner’s network and setup monitoring.

c. Altronix #Linq2 or equal

D. Access Power Controllers

1. The Power Controller shall have the following characteristics:

a. Powered by 12 VDC or 24 VDC from the power supply/charger board or via 8-Pin connector to stack with Voltage Regulator for dual voltage (12VDC & 24VDC) outputs from a single 24VDC input, up to 6 Amps

b. Spade lug connectors to facilitate the transfer or sharing of 12VDC and/or 24VDC power between Access Power Controllers or Power Distribution Modules
c. 8 trigger inputs to correspond with similarly numbered triggered controlled outputs, with each trigger input being in one of the following forms:
   1) Normally open (NO) contact
   2) Open collector

d. 8 independently trigger-controlled outputs with the following output options:
   1) Fail-Safe filtered and electronically regulated power outputs
   2) Fail-Secure filtered and electronically regulated power outputs
   3) Form "C" relay outputs, rated 5 amps @ 28 VDC/VAC.
   4) For each triggered output, LED indication of an active output.
   5) Bi-colored LEDs for visual verification of voltage (12VDC or 24VDC) per output
   6) An unswitched auxiliary power output, rated at 2.5 amps (fused) or 2 amps (PTC), used in lieu of a trigger-controlled output.
   7) Fuse protected

e. FACP (Fire Alarm Control Panel) interface
   1) input options from the FACP:
      A) polarity reversal
      B) Normally Open - Non-Latching or Latching with reset
      C) Normally Closed - Non-Latching or Latching with reset
   2) Ability for the FACP to trigger any of the trigger-controlled outputs
   3) Trigger indications:
      A) LED indicator on the module
      B) Form "C" output relay contact rated 1 amp @ 24 VDC

f. Current protection
   1) access control module: 10 amp fuse
   2) individual outputs: 2.5-amp Class 2 rated PTC device

2. Access power controller shall be Altronix #ACMS8 or equal.

E. Power Distribution board with voltage regulator.
   1. The Power Distribution Module shall be a UL Listed Sub-Assembly board level product comprised of fused protected outputs to furnish 12 VDC, 24 VDC or 24 VAC power to surveillance, security, access control systems and components, and other security-related equipment.
   2. Power distribution module shall include:
      a. The Power Distribution Module shall employ a single distribution board.
      b. The Power Distribution Module shall output 5VDC to 24VDC up to 10A each or 16VAC to 28VAC up to 14A each.
      c. Fused protected outputs.
      d. Individual voltage LEDs indicate 12VDC (Green) or 24VDC (Red and Green)

3. Modules shall provide for:
   a. Dual Power Supply Inputs.
   b. Outputs shall be switch selectable as to route power via Input 1 or Input 2.
   c. Shall be stacked with a voltage regulator and connected via eight (8) pin connector.
   d. Individual voltage LEDs indicate 12VDC (Green) or 24VDC (Red and Green).
   e. Eight (8) individually fused device protected outputs.

4. Power distribution board shall be Altronix #PDS8 or equal
   a. Equip with a voltage regulator Altronix #VR6 or equal.

F. Battery Backup
   1. The enclosure shall have battery backup UPS circuit with built-in battery charger that shall provide automatic battery backup UPS power in event of AC line failure.
   2. Each controller enclosure panel shall have a battery for power failure. Battery shall be fully enclosed in a metal cabinet.
   3. The battery shall provide for full UPS operation for a minimum of 30 minutes

2.07 MASTER CONTROLLER
A. See floorplans for controllers and locations

B. Provide controller as required to connect panels in each separate room where panels are installed. No RS-485 connections are allowed between comm rooms.
   1. Master Network controller
      a. Shall be Cbord #V-1000
   2. Master Controllers shall communicate to the existing OneCard software via the University Ethernet Network.
      a. Install CAT-6 cables to connect the controllers to the Ethernet network.
   3. Connect to power distribution in the enclosure.

2.08 2-DOOR CONTROLLER
A. 2-door panel. Connect to the Master Controller
   1. Provide as many of these as are required for system connectivity of all doors and access control devices.
   2. Shall be Cbord #V-100

2.09 CARD READER
A. Card Readers: “CR” on drawings
   1. Card readers shall be mounted on a single-gang backbox.
   2. Card reader shall be Schlage #MTMS15
   3. Shall have proximity reading and swipe magnetic reader

2.10 DOOR LOCKING DEVICES
A. Electric Latch “EL” on drawings
   1. The door hardware installer will install an Electric Latch device at each door equipped with a card reader or as shown on the drawings. The security contractor shall wire from the EL device to a power supply in the communications room and then to the door controller in the communications room.
   2. Provide cards in the controller panel and equipment to allow the security system to interface with the EL.
   3. The EL shall be able to be held open based upon a time schedule put forth in the security system. It shall also be able to be retracted upon presentation of a valid card or fob to the card reader.
   4. Wire to the Electric Latch and fully integrate it into the security system.
   5. Wire from the EL to the controller in the comm room to allow control of each individual door.
   
B. Latch Retraction device: “LR” on drawings
   1. The door hardware installer will install a Latch Retraction device as shown on the drawings.
   2. Provide and install a power supply in the communications room to power the LR device. Review the door hardware and match the power supply to the Latching Retraction devices. Provide quantity as required to power all LR devices
   3. The security contractor shall wire from the LR device to a power supply in the communications room and then to the controller panel in the communications room.
   4. Provide cards in the controller panel and equipment to allow the security system to interface with the LR.
   5. The LR shall be able to be held open based upon a time schedule put forth in the security system. It shall also be able to be retracted upon presentation of a valid card or fob to the card reader.
   6. See door hardware specifications for transfer hinge and wiring harness provision plans.
      a. If wiring harness is provided as part of door hardware:
         1) Wire from door harness, through raceway and back to the power supply in the comm room. Wire to security panel for control of the door.
         2) Provide custom wiring and connectors to connect to the wiring harness
      b. If no wiring harness is provided as part of the door hardware.
1) Wire from the LR, through the hinge and back to the Power Supply in the comm room. Wire to security panel for control of the door.

c. Provide manufacturers recommended cabling type and wire gauge.

C. Magnetic Lock “ML” on drawings
1. The door hardware contractor shall install the Magnetic locks.
2. The contractor shall wire from the ML to the security panel. Provide cabling to control the ML and power the ML.
3. Provide power supply in the comm room to power the ML.
4. Connect panel to the Fire alarm so that when there is a fire alarm event the Magnetic locks disengage.

2.11 DEVICES AT THE DOOR
A. Door Contacts; “DC” on drawings
1. Contractor shall install magnetic door contacts in the top of each door required to be monitored. See drawings for door contact “DC” locations.
2. Contacts are provided as part of the door hardware specification.
3. Contacts shall connect back to the controller via wire installed by the Contractor.
4. In locations where there are double doors, two contacts shall be installed, and the connections shall be made so that the opening of each door is detected.
5. When the contact is installed in the recessed part of a metal doorframe, an appropriate, solidly attached metal support shall be used. The tolerance “gap” shall be adjusted to the frame and the door.
6. Wire door contacts back directly to an I/O card in the controller panel. DC’s shall not be wired through Request to Exit devices.

B. Hard-wired Request to Exit devices “RX” on drawings
1. These devices are located in the latch retraction devices or electric lock devices.
2. These devices are provided and installed by the door hardware contractor.
3. Security contractor shall wire from the RX to the I/O panel in the network controller.

C. Door Position Switch. “DP” on drawings
1. Door position switch is in the door hardware, provided as part of the lock.
2. Wire from this device to the security system to inform the system to the status of a lock.
3. Configure to allow other functions to happen or not happen. Talk with owner regarding requirements.

2.12 WIRES AND CABLES
A. The contractor shall be responsible for supplying and installing all cabling to make the system operational.
1. All cabling shall be Plenum rated
2. All cabling shall be installed in raceways and in accessible ceiling spaces through cable supports.
3. Provide manufacturer specified cabling based on use and length of signal transmission from panel to device.
4. Generate drawings showing the cables required and get those reviewed by the designer prior to installation.

B. PVC-Jacketed, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
1. NFPA 70, Type CM.
2. Flame Resistance: UL 1581 Vertical Tray.

C. Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
1. NFPA 70, Type CMP.

D. RS-485 communications require 2 twisted pairs, with a distance limitation of 4000 feet (1220 m).

E. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.

F. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket.
   1. NFPA 70, Type CMP.

G. Multi-conductor, Readers and Wiegand Keypads Cables: No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 percent shield coverage, and PVC jacket.
   1. NFPA 70, Type CM.
   2. Flame Resistance: UL 1581 Vertical Tray.
   3. For TIA/EIA-RS-232 applications.

H. Paired Readers and Wiegand Keypads Cables: Paired, 3 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
   1. NFPA 70, Type CM.
   2. Flame Resistance: UL 1581 Vertical Tray.

I. Paired Readers and Wiegand Keypads Cable: Paired, 3 pairs, twisted, No. 20 AWG, stranded (7x28) tinned copper conductors, polyethylene (polyolefin) insulation, individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded (19x34) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
   1. NFPA 70, Type CM.
   2. Flame Resistance: UL 1581 Vertical Tray.

J. Plenum-Type, Paired, Readers and Wiegand Keypads Cable: Paired, 3 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, individual aluminum foil-polypropylene tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and fluorinated-ethylene-propylene jacket.
   1. NFPA 70, Type CMP.

K. Plenum-Type, Multiconductor, Readers and Keypads Cable: 6 conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.
   1. NFPA 70, Type CMP.

L. Paired Lock Cable: 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
   1. NFPA 70, Type CMG.
   2. Flame Resistance: UL 1581 Vertical Tray.

M. Plenum-Type, Paired Lock Cable: 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
   1. NFPA 70, Type CMP.

N. Paired Lock Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
   1. NFPA 70, Type CMG.
   2. Flame Resistance: UL 1581 Vertical Tray.

O. Plenum-Type, Paired Lock Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.
1. NFPA 70, Type CMP.

P. Paired Input Cable: 1 pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, overall aluminum foil-polyester tape shield with No. 22 AWG, stranded (7x30) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
1. NFPA 70, Type CMR.

Q. Plenum-Type, Paired Input Cable: 1 pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, aluminum foil-polyester tape shield (foil side out), with No. 22 AWG drain wire, 100 percent shield coverage, and plastic jacket.
1. NFPA 70, Type CMP.

R. Paired AC Transformer Cable: 1 pair, twisted, No. 18 AWG, stranded (7x26) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
1. NFPA 70, Type CMG.

S. Plenum-Type, Paired AC Transformer Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.
1. NFPA 70, Type CMP.

T. Elevator Travel Cable: Steel center core, with shielded, twisted pairs, No. 20 AWG conductor size.
1. Steel Center Core Support: Preformed, flexible, low-torsion, zinc-coated, steel wire rope; insulated with 60 deg C flame-resistant PVC and covered with a nylon or cotton braid.
   c. Braid: Rayon or cotton braid applied with 95 percent coverage.
   d. Jacket: 60 deg C PVC specifically compounded for flexibility and abrasion resistance. UL VW-1 and CSA FT1 flame rated.

PART 3 - EXECUTION

3.01 EXAMINATION
   A. Examine all pathways prior to installation of all cables and raceways.
   B. Install all conduits, pass-thru’s, raceways and surface mounted raceways prior to installing the security system devices and cabling.

3.02 PREPARATION
   A. Locate main path for all cables and install J-hooks where cable tray is not provided.
   B. Coordinate with other trades to install a clear, straight path down major corridors for the routing of security/access cables back to the communications closet.
   C. Plan installation of cables along wallfield in communications room. Provide finger-duct and D-rings for support of cables. See drawings

3.03 INSTALLATION-GENERAL
   A. Security/access cable shall be installed per industry standards.
      1. Install all cabling required for complete system connectivity. Cabling shall be plenum rated.
2. Care shall be taken to avoid crimping or bending the cable past the manufacturer’s recommended bend radius.
3. During installation, the cables shall not be pulled across the ceiling tiles or the structure of the building. This may cause damage to the cable jacket.
4. Adhere to all pulling tensions and bend radii during installation.
5. All cables shall route neatly in the ceiling. Whether they route in cable tray or J-hooks, the cables shall be neat and orderly.
6. Support cables at a minimum of every 5 feet.
7. When routing security/access cables parallel to electrical conduits and lighting ballasts, the cable shall maintain a clearance of at least 12 inches. When running perpendicular to electrical conduits and lighting ballasts the cable shall maintain 6 inches of clearance.
8. Provide a short coil of extra cable where the cable enters the vertical conduit. The coil shall consist of no less than 1-1/2 feet.
9. When installing cables in the communications room, all cable shall route neatly through the cable tray and cable ladder.
10. Provide a service loop of the cables on the wallfield.
11. Each cable shall have a self adhesive, self laminating, laser printed label at each end. The label shall show the location identifier of that cable. Labels shall be installed no more than 4 inches from the termination point of the cable.

B. Firestopping is required at all riser conduits, and all pass thru’s.
1. Each cable tray penetration of a wall shall be firestopped after cable installation. Use pillow type firestop to allow additional cables to be installed in the future.
2. Where riser conduits pass through floors, the area between the concrete and the conduit shall be firestopped. This shall be completed with a putty or liquid firestop product. Fill the space with mineral wool, and then install the firestop on top. All firestop shall be of sufficient thickness to secure the rating required by code.
3. After final cable installation, install a putty firestop around all cables where they enter and exit conduit pass thru’s and conduit risers.
4. Firestop as per AHJ requirements.

C. Cabling at the Panel.
1. Contractor shall coil all spare cable from the door devices outside the security panel and shall neatly coil the cable on the wall. Provide 5’ minimum in the coil for future movement of the panel.
2. Cables shall route into the panels through a grommeted hole that is sized for the cables entering.
3. All cables shall be installed in a neat and workmanlike manner.
4. Cables shall be terminated and shall allow for removal of a card without un-terminating the cables.
5. All cables shall be neatly distributed to the card in the panel.
6. All labels shall be visible inside the panel near the termination point. Label cables equidistant from their termination point.

D. Proper support of cables is of paramount importance when installing a cable infrastructure. All cables not in conduit or cable tray shall be supported via J-hooks a minimum of every 5 feet.
   1. Routes of cables shall be parallel or perpendicular to the walls of the building.
   2. Install the J-hooks to minimize changes in the level of the cables as they route through the J-hooks.
   3. All communications shall route as high in the ceiling as possible while still being accessible and staying away from other utilities.
   4. When installing the cable through the J-hooks, they shall all have relatively the same droop between hooks. All cables shall be installed neatly and squarely.
   5. Secure the J-hooks to the building structure with beam clamps and threaded rod as required to support the cables.
   6. J-hooks shall never be attached to drop ceiling support wires. Cables shall never be supported by drop ceiling wires.

E. Raceways.
   1. Shall be mechanically attached to the wall or door.

3.04 SERVER AND SOFTWARE INSTALLATION

A. Management Server:
   1. Server is existing
   2. Provide and apply any software required to support the new devices being installed.

B. Control Software:
   1. Contractor shall schedule meetings with the Owner prior to installation to determine the working of the security/access system.
   2. Configuration of the security software shall include but not be limited to the following:
      a. Users are already in the system.
      b. Number each door and any input and outputs associated with that door and associate it with a standard door name for easy review.
      c. Meet with the owner to determine how they will use the system. Take information from them that will allow all custom settings of the software system. This shall include but not be limited to:
         1) User groups based on building and administrative group
         2) Access levels based on groups and times.
         3) Door Groups for access and locking and unlocking schedules.
         4) Building locking and unlocking schedules for each building
         5) Administrative levels and super administrators
         6) Building arming and disarming schedules of door contacts
         7) Alarm level setting for different doors based on time of day and day of week.
         8) Normal locking schedules.
      d. Generate customized maps for each building.
         1) Create maps from the owner that have multiple levels such as entire building and then subdivided into different areas.
         2) The maps shall show icons for each door. The icons shall be green or red based on open or closed door.
         3) Setup all icons to allow the owner to click on a door and then have direct access to lock or unlock or pulse the lock on a door.
      e. Setup all user accounts and install the user software on the owner’s PC’s.
         1) Setup the user accounts based on the doors or buildings they will be allowed to control.
         2) Work with the owner to determine which panels, doors, maps or buildings the user will be able to see and control.

3.05 CONTROL PANEL INSTALLATION
A. Enclosure and power
   1. Contractor shall mount the enclosure on top of ¾” fireproof plywood.
   2. Mount enclosure in the location noted. Coordinate other equipment and wallfield systems.
   3. Locate the 120 volt power outlet and install enclosure in relation to power.
   4. Size the enclosure to support all PACS devices noted on the drawings and in the specifications.
   5. Provide magnetic cable support devices in the panel to route cables inside the pane to the controllers and power devices.
   6. Power.
      a. Install cabling and raceway to connect the power supply in the enclosure to the 120 volt power outlet.
      b. Shall be hard-wired power. Plug-in power is not allowed.
      c. Provide an electrician for connection of the power supplies if required by AHJ.
   7. Battery backup
      a. Provide and connect the batteries to the power supply for the enclosure.
      b. Test the battery supports the panel by removing 120 volt power after the system is fully up and operational.
   8. Network connectivity
      a. Provide and install CAT-6 cable from the enclosure for the power supply to the communications rack. Connect to the Ethernet switch.
   9. Other Controllers and I/O Board connectivity.
      a. Provide and install cabling to connect the Ethernet controller to the other controllers and I/O boards via RS-485.
      b. Do not install RS-485 between communications rooms. Each comm room shall have an Ethernet attached Controller.

B. Controller:
   1. Controller(s). shall be mounted in the enclosure as shown on the drawings.
   2. Controller shall be sized for all security, access, control, and monitoring points existing on the drawings and shall be expandable.
   3. Controller shall be able to be linked to additional controllers in other communications rooms/buildings via the Ethernet network.
   4. Each port in the controller that is connected to a security point shall be labeled inside the controller box.
   5. Label the outside of the panel with the door numbers and list of devices that are connected in that panel. Shall be laser printed adhesive labels.
   6. Label the inside of the panel door with the layout of the panel and which controllers attach to which devices. Include door numbers on the diagram.
   7. Depending on the type of panel the contractor shall provide cable routing hardware and equipment to neatly install cabling.
      a. Route cable to allow easy change and replacement of the individual control cards in the panel.
      b. Cabling shall be neatly bundled. See example below of adequate cabling being routed into a panel.
   8. Network connectivity
      a. Provide and install CAT-6 cable from the controller to the communications rack. Connect to the Ethernet switch.
      b. Connect on the Ethernet to the Switch.
   9. Wire and install the panel to look like this:
10. Fire Alarm integration “FA
   1. Wire from the enclosure/controller to the Fire Alarm system
   2. Provide all cabling and i/o ports to accept inputs from the fire alarm or trigger the fire alarm panel.
   3. Work with the fire alarm provider to support integration between the PACS and Fire alarm. That may include:
      a. Release of Hold opens for doors in a lockdown
      b. Release of magnetic locks during a fire alarm event
      c. Release of electronic locks during a fire alarm event.
      d. Others as defined by the owner.

3.06 DOOR LOCKING CONNECTIVITY
   A. Electric Latch “EL”, Magnetic Lock “ML” on drawings
      1. The note devices shall be installed by the door hardware contractor.
      2. Power supplies shall be located in the comm room. Provide and install power supplies.
         Connect power supplies to the controller panel.
      3. Install all cables required to be connected this device to the security system
      4. Review door hardware specifications to determine if a wiring harness is being provided by the door hardware supplier.
         a. Install cables from the controller panel and power supply in the comm room to the wiring harness. Connect to harness
         b. For EL devices, install harness from door hardware EL to the hinge, through the hinge and to the connection point for cables from the controller.
         c. For ES devices, install cabling from security panel to the Electric strike in the latch side of the frame.
         d. Wire from device, through frame and back to controller/power supply in the comm room.

3.07 READER INSTALLATION
   A. Card Readers “CR” on drawings
1. Card readers shall be installed at locations shown on the drawings.
2. Review site and drawings and coordinate the wall mounted readers and frame mounted readers. Order the correct reader for each location.
a. Conduct a site visit prior to ordering card readers.
b. If the wrong reader is ordered then the contractor shall provide the correct reader.
3. Coordinate installation of all card readers with the doors and walls.
4. Where the reader is mounted on the door, coordinate the installation with the installation of the door to allow all cable for security/access.
5. Locate all card readers at ADA compliant heights and locations.
6. Wire and configure the card readers so that when the lock is engaged the light on the reader is red and when the door is unlocked the light is green.
7. Garage Doors and Pedestals: At the garage doors and at pedestals the card readers shall be installed with a box that has a cover for the top of the card reader.

3.08 DEVICES AT THE DOOR
A. Door Contacts “DC”:
   1. Install contacts where shown on the drawings. For door contacts, install them at the top of the door.
   2. Work with door provider and installer on timing of door contact installation.
   3. Install raceways to allow installation of the door contacts if no raceway is provided inside the wall.
   4. Drill into the door frame and door to allow installation of the door contact and the associated cable. No cable shall be visible after installation.
   5. Where door frames are filled, they shall be drilled out to allow installation of the door contact. Surface mount contacts are not allowed at any student accessible doors.
B. Request to Exit Devices “RX” on drawings
   1. When the RX is shown, wire from this device in the lock/pushbar, back to the controller in the comm room.
   2. Set this up to shunts the door contact when triggered.

END OF SECTION 28 35 00
PART 1 - GENERAL

1.01 SECTION INCLUDES
A. This section includes parts and equipment required for installation and termination of a building-wide Access Control and Intrusion Detection System. This system shall be referred to as the "security system" throughout these specifications.
B. The owner utilizes Johnson Controls Cardkey Pegasys 2000 as the access control system and intrusion detection. No other systems are allowed

1.02 SYSTEM DESCRIPTION
A. The security system shall be supplied and installed by a Contractor able to show examples of similar projects and installations within the last 3 years.
B. The security system shall be an extension of the existing system at the WSU Campus.
C. The Security System shall provide a solution for access control and intrusion detection systems.
D. Contractor shall provide all software required for connection of the security system to the in-house data network and associated control PC’s and existing Pegasys server.
E. The security system client-server architecture shall communicate with native TCP/IP over an existing Ethernet TCP/IP enterprise network.

1.03 COORDINATION
A. All cables shall be coordinated with the doors and door hardware being installed as part of this project.
B. Access Control/Intrusion detection cable shall be a unique color from the Telecommunications cable, fire alarm cable and lighting control cable. Coordinate this with the Electrical Contractor prior to ordering the equipment and installation of the cables.

1.04 PROJECT PLAN
A. The contractor shall provide a project plan to the owner and contractor that describes the system and its capabilities and the possible configurations.
B. Provide a project approach which describes the installation and implementation plan and schedule and all sequencing.
C. Meet with the owner numerous times to determine how the system should work and how it should be monitored. Configure the system prior to installation to meet these requirements. Demonstrate the system use to the owner prior to installation and obtain approval to move forward with the installation.
D. Contractor shall conduct numerous site reviews to establish pathways and routes for all raceways required.
E. Provide shop drawings showing all configuration and connectivity of the system.
1. Include elevation view of panels and which doors each panel will support
2. Include one-line connectivity including devise at each door and all other devices to be controlled or monitored.
F. Generate a testing plan and have that plan approved by the owner and engineer prior to installing the system.
G. The system shall be installed and tested prior to cutting over any doors to the system. Provide and install temporary card readers, door contacts etc to the system for testing. Demonstrate that this works prior to cutover.
1.05 RELATED STANDARDS
A. The security system shall conform to the following international and national standards:
1. FCC Rules and Regulations
2. UL 294 Access Control Systems
3. UL 1076 Line Supervision
4. 21 CFR part 11
5. Part 15, Radio Frequency Devices
7. Applicable Federal, State and Local laws, regulations, codes
8. Americans with Disabilities Act (ADA).

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Approved vendors for security cables are:
1. General Cable.
2. Belden.
3. West Penn Wire and Cable.
4. Equivalent manufacturers.
B. Approved vendor for access control/intrusion detection systems equipment is:
1. Cardkey Pegasys 2000

2.02 MATERIALS
A. All security and control cables shall be plenum rated.
1. Contractor shall provide all appropriate cable from the door security hardware to the security system. All cabling shall be plenum rated.
2. Some locations require outdoor rated cabling. The contractor shall provide the cabling to match the required area.
3. There will be requirements for many different types of cabling and the contractor shall provide for each.
4. Provide a coil of cable at each location for moves and maintenance.
B. The system shall be fully configurable and compartmentalized so that any user can be assigned, and they will only see the status of doors at one building.
1. Based on a user’s login, the system shall be configurable to restrict persons from seeing or controlling doors and lock schedules at building that they do not have permission to see or control.

2.03 SECURITY SYSTEM SERVER
A. Management Server:
1. Server is existing at the owner’s data center. It is a Pegasys P2000 server.
2. Provide all work and any additional software from Pegasys as required

2.04 SECURITY SYSTEM SOFTWARE
A. Software shall be an extension of the Cardkey Pegasys 2000 system,

2.05 ENCLOSURE
A. Shall be provided to hold power supplies, controllers, access control processors, card reader boards, input/output cards (now to be referred to as security panels) and any other components required for a complete access control system.
B. Security enclosures are the physical boxes and cabinets that support the intelligent controllers, I/O boards, power supplies and power distribution equipment.
C. Security panels hall be wall mounted and large enough to hold power equipment and access control system controllers and cards.
D. Security panel shall be:
1. Enclosure shall accommodate power supply and sub-assemblies such as controllers and security cards to be provided as part of the project.
2. Primary power input shall be 120VAC
3. Physical
   a. Size enclosure as required to hold power supplies and security panels. Provide multiple enclosures where required.
   b. Made of 16 AWG sheet metal
   c. Shall have conduit knockouts or custom cut holes for access to the panels for cabling.
   d. Be equipped with an internal cam lock
   e. Be equipped with a tamper switch that shall be wired to the I/O for software alarm when the panel is opened.
   f. Shall have space for batteries to support the access control system.
4. Equip with a backplate or DIN Rail that shall support direct mounting of the security panels and power devices.
5. Equip with magnetic cable supports that attach to the backplate to support cables.
6. Use # 237 cam lock for JCI Cardkey panels.

E. Security Enclosure for Pegasys equipment shall be Johnson Control S300-DIN series.
F. Any other enclosures provided shall be metal and shall be marked for what they contain.

1. Equip any non-Johnson Controls enclosures with a Tamper Switch, GE #3012-N. connect to Control Board for monitoring.
2. Monitor power failure of the power supplies in these enclosures.
   a. Power fail circuits must be configured to monitor for extended power loss, not power “bumps”. Circuit/device protection (fuses) must be included and designed to expedite troubleshooting of the alarm system.
3. Use CCL # 15748-US26D-C4L-KA4T3252 for terminal cabinets.
   a. Terminal Cabinet Locks may require Brass Spacer CCL # 2540 x US4 for proper operation of tamper switch.

2.06 ACCESS CONTROL PROCESSOR (ACP)
A. See floorplans for controllers and locations, a minimum of one per building.
B. The ACP is the main control processor for each building and stores all the pertinent data for that respective building i.e.
   1. Card holders,
   2. Monitor points,
   3. Output control points,
   4. Time schedules, locking and unlocking schedules etc.
C. The ACP shall interface with multiple terminal boards (e.g. reader boards, input boards, and output boards) and also communicates directly with the P2000 Server.
D. Each building is equipped with an access control processor, Johnson Controls # CK721A ACP.

2.07 POWER SUPPLIES
A. Power supplies and power equipment shall be provided that support the entire access control system, security panels/controllers, door locks and all other field equipment of the access control system.
B. All power supplies shall be connected to 120VAC power with a hardwired connection. Install cable and connect to power.
   1. Provide and install conduit, wiring and connections required for 120-volt power connectivity.
C. Power supply shall be mounted to the enclosure. Shall include:
   1. Shall provide power to the panels in the enclosure and field devices.
   2. Shall include multiple 12 or 24 volt outputs. Shall be settable in
   3. Input voltage of 120VAC with a fuse
4. Classified as a Power-Limited stand-alone power supply with stand-by battery and suitable to power sensors and electro-mechanical devices (e.g. electric door strikes), as defined in the National Electrical Code/NFPA70/NFPA72
5. Shall be sized for outputs of 1 thru 16 unique outputs.
6. Battery connection for charging on-board batteries.
7. LED indicators for:
   a. AC input
   b. DC output
   c. Battery discharged or no battery
8. Over Voltage protection
9. Short Circuit protection
10. Power supply shall be Altronix #AL60ULX.

D. Battery Backup
   1. The enclosure shall have battery backup UPS circuit with built-in battery charger that shall provide automatic battery backup UPS power in event of AC line failure.
   2. Each controller enclosure panel shall have a battery for power failure. Battery shall be fully enclosed in a metal cabinet.
   3. The battery shall provide for full UPS operation for a minimum of 30 minutes
   4. A 12v/7Ah gel cell battery must be provided with every equipment cabinet containing a power supply for controllers or terminal boards. Install and connect inside the enclosure.

2.08 CARD READER BOARD
A. The Contractor shall provide intelligent controller modules / boards for the security system that utilize a true distributed processing technology with local processing at each controller.
B. One module per communications room or immediate adjacent enclosures shall provide for communications with the server/software via on-board 10BaseT/100BaseTX Ethernet port and support TLS encryption as a minimum-security implementation.
C. In the event system communications is lost or the server/cloud fails, all networked intelligent controller, (controllers or security panels or modules, terms will be used interchangeably) shall provide complete control, operation, and supervision of all monitoring and control points based on the latest database information.
D. Two-reader/door boards shall be Johnson Controls S300-DIN-RDR2SA.
E. Eight-reader/door boards shall be Johnson Controls S300-DIN-RDR8SA
   1. This shall serve as the interface between the card reader and the ACP.

2.09 CONTROL BOARDS
A. Input / Output I/O control boards shall be installed in the enclosures and attached to the ACP to allow input and output to the field devices throughout the building(s).
B. I/O boards shall monitor both supervised and non-supervised devices. Each board can be configured and terminated for supervision to support critical device, such as the reporting of Fire Alarm, Fire Trouble and Fire Supervisory alarms to WSU PD
   1. One board in each building shall be on Terminal 1 inputs 1, 2 & 3 as noted:
      a. Terminal 1 -Fire Alarm,
      b. Terminal-2 -Fire Trouble
      c. Terminal-3 -Fire Supervisory alarms
   2. Non-supervised devices that may be connected to these boards include but not limited to
      a. Perimeter doors,
      b. Roof hatches and roof doors,
      c. Environmental alarm devices,
      d. Glassbreak detectors,
      e. Motion detectors,
      f. Water detectors etc.
      g. Each building on campus is required to have at minimum (1) S300-DIN-I8O4 input board configured to report supervised alarms.
3. The S300-DIN-I8O4 or S300-DIN-I32O16 input/output control board shall be utilized to control devices remotely (e.g. unlocking perimeter doors on time schedules, resetting glass break detectors, shunting alarm points during business hours).

4. Provide additional modules or boards to support all control, access and security points shown on the drawings and described in the specifications.

5. Modules shall be installed to connect to the field devices, including but not limited to:
   a. Door contacts,
   b. Request to exit devices,
   c. Push buttons/Panic buttons
   d. Toggle Switches
   e. Assisted door opener devices and door opener buttons
   f. Motion sensors.
   g. Strobe lights
   h. Glass Break Sensors
   i. Embarrassment alarms / exit alarms
   j. Lockdown buttons with Lockdown Status Light
   k. Other field devices noted
   l. All other security devices required and shown on the drawings.

6. Control Boards shall translate information from the field devices to the controller and thus the server for records and access control.

C. 8-input and 4 output control board shall be Johnson Controls #S300-DIN-I8O4
D. 3-input and 16 output control board shall be Johnson Controls #S300-DIN-I32O16

2.10 FIBER OPTIC CONVERTER
A. Each building that has an access control system shall be connected to Wayne State University (WSU) police for monitoring.
B. The fiber optic converter shall connect to the APC with a CAT-6 able
C. Install the converter in the communications rack.
D. Equip with a UPS for power. Install the UPS on a shelf in the rack.
E. Connect the Fiber converter to the APC in the room and the WSU network at the other end of the connection.
   1. Provide all fiber and copper patch cables.
F. Fiber converter shall be Radiant Communications #DLL-SM-RE3 with SC type connectors
G. UPS Shall be APC #BK350 or equal

2.11 INPUTS AND MONITORING REQUIREMENTS
A. The system must have perimeter security using door switches shunted for request to exit (RX) and glass break protection rather than motion detection.
B. Perimeter security will monitor all doors for both door position and latch position.
C. Use RX (Request to Exit) switches mounted inside (latch retraction) rim/panic device.
D. All security devices shall be monitored for tampering, including all card readers, all alarm control keypads, all motion sensors and all glass break sensors.
   1. Tamper alarms for security devices shall be wired to separate input points than their respective security device's input point.

2.12 CARD READERS
A. Refer to the drawings for locations where card readers “CR” are required.
B. Card readers shall be combo readers that read standard 125 khz readers for standard prox and 13.56 MHz “smart” cards and 2.4Ghz (Bluetooth) compatibility.
C. Card readers shall be completely compatible with the security/access system.
D. Card readers shall be mountable in a single gang box or in the frame of a door. Refer to drawings for locations.
E. Readers shall be sealed to allow outdoor installation.
F. Reader shall be 3-stripe magnetic reader
G. Card reader shall be Mercury Security #MS-BR20-OW-T3
   1. Equip with a Magnetic switch, Sentrol #1035W
2. Equip with a Weatherized rain hood

2.13 BUILDING PERIMETER DOORS
A. Exterior doors shall be equipped with Latch Retraction pushbars.
B. Latch Retraction device: "LR" on drawings
   1. The door hardware installer will install a Latch Retraction device at each door equipped with a card reader or as shown on the drawings.
      a. Vertical rod exit devices are not allowed.
   2. The security contractor shall wire from the LR device to a power supply in the ceiling and then to the door controller in the communications room.
   3. LR devices are to be fitted with
      a. LR (Electric Latch Retraction) functionality,
      b. RX (Request to Exit) monitoring switch,
      c. DS (Latch Bolt monitor switch, Sentrol #1078
      d. LC (Low Current) - rated contacts.
      e. All LR devices shall be mounted to doors per Allegion specifications which include using 10x24x1" pan head Phillips-type machine screws with holes drilled and tapped to accommodate said machine screws. Case covers and end caps shall be secured with the Phillips-type screws provided with the rim device.

2.14 ROOF AND MECHANICALROOM DOORS
A. Equip each with a door contact "DC". Sentrol #1028.wire to security system
B. Doors to be monitored on a schedule. Consult WSU Police alarm system administrator for specific times.
C. Custom Signage shall be installed at roof hatch indicating the hatch is armed and to contact WSU Police before opening.

2.15 PERIMETER OVERHEAD GARAGE DOORS.
A. Equip each with a garage contact “GC”. Sentrol 2205AL x 1912L surface-mounted overhead magnetic door switch.
B. Custom signage shall be installed at the garage door indicating that the garage door is armed and to contact WSU Police before opening.

2.16 ROOF HATCHES
A. Equip each with a door contact “DC”. Sentrol 2505A x 1912L surface-mounted, magnetic door switch to be installed on all roof hatches.
B. Roof hatches are to be monitored on a schedule. Consult WSU Police alarm system administrator for specific times.
C. Custom Signage shall be installed at roof hatch indicating the hatch is armed and to contact WSU Police before opening.

2.17 ADA AT DOORS
A. ADA assisted Openers
   1. At some doors there are assisted openers. At these doors the access control system shall completely work with the opener. Include equipment and programming to allow the doors to function as per below:
      2. Exterior ADA actuators must be disabled whenever the electrified hardware is locked and enabled only after the card and/or PIN have been presented at the reader to allow access.
         a. When approaching from the exterior and doors are locked:
            A) Present a card and then door shall be unlocked. Push the auto opener and the door shall open.
         b. When approaching from the exterior and doors are unlocked:
            A) Push the auto opener button and the door opens.
         c. When approaching from the interior and doors are locked:
            A) Push the auto opener button and the door shall unlock and open.
         d. When approaching from the interior and doors are unlocked:
A) Push the button and the door opens.

2.18 PERIMETER BUILDING PROTECTION.

A. All perimeter glass accessible from grade or some other nearby elevated platform (e.g. overhangs, canopies, half story roofs, second story roofs, adjacent buildings, trees, etc.) are to be protected with Glassbreak Sensors or PIR Motion Sensors.

B. Perimeter monitoring devices shall be interfaced with the building ACP input and output boards and are monitored and controlled by WSU Police via the P2000 Server.

C. All perimeter sensors are connected to individual inputs on JCI I/O boards. WSU Police must have the ability to shunt, arm and disarm all perimeter sensors via outputs on the JCI I/O boards. Consult with WSU Police alarm system administrator for specific intrusion alarm programming configurations.

D. Acceptable sensors are as follows:

1. Glass Break Sensors “GB” on drawings
   a. Install glass break sensors as noted on the drawings.
   b. Install based on manufacturers recommendations
   c. Wire to the access control/intrusion detection system.
   d. Perimeter monitoring devices shall be interfaced with the building ACP input and output boards and are monitored and controlled by WSU Police via the P2000 Server.
   e. All perimeter sensors shall be connected to individual inputs on JCI I/O boards. WSU Police must have the ability to shunt, arm and disarm all perimeter sensors via outputs on the JCI I/O boards.
   f. Consult with WSU Police alarm system administrator for specific intrusion alarm programming configurations. Acceptable sensors are as follows:
      g. GB (Glassbreak Sensor) shall be Honeywell #FG-1625/T break sensors.
         A) Where multiple glass break sensors are located in close proximity to each other, they must be wired to a nearby centrally-located junction box.
         B) The glass break sensors must be wired in series with each other to said junction box with a single cable pair wired to the JCI I/O board.
         C) This configuration reduces the number of required inputs. The junction box must contain termination strips and associated components required for proper monitoring and control of the sensors. Junction boxes must be documented on s-Bult drawings as a single zone and include all termination points, cable colors, cable types, etc.
         D) Sensors wired in a daisy chain configuration are not acceptable. A dedicated output on the JCI I/O board controlled by WSU Police is required to remotely reset power to sensors after activation.

2. Vestibule Glassbreak Sensor “GB-V” shall be DSC BV-502GB
   a. This glassbreak sensor to be used when protecting entryway vestibule glass doors.
   b. GB-V sensors must be home run to the JCI I/O board and not part of a zone configuration. Motion sensor shall shunt glassbreak sensor when pedestrians are exiting the building.

3. PIR Motion Sensor “MD” shall be Visonic SRN-2000 PIR Motion Sensors.
   a. PIR sensors are only acceptable when interior spaces are not occupied after normal business hours and building is armed by scheduled output from P2000 Server.

2.19 SECURITY CONTACTS/CONTACT CLOSURES: “SC”

A. Contractor shall provide an interface in the controller for connections to dry contact closures of other systems.
   1. Dry contact shall cause an alarm on open or closed state depending on Owner required configuration of the controller.
   2. Contractor shall provide all cabling and configuration required interfacing the security/access system with all security contacts.
3. Contacts shall be provided as per the drawings and shall interface with the other systems as shown.
4. Equip each LCD and video projector with an SC device
5. Security Contacts for LCD Displays and Projectors shall be Sentrol #MagnaPull

2.20 INTERCOM – IP BASED
A. Intercom at doors; “IC” on drawings
   1. At locations shown on the drawings, the Contractor shall install audio (IC) Intercom devices to allow visitors to contact the office to announce themselves and to gain entry into the building.
      a. Connectivity of the components shall be via CAT-6 cables from the Intercom to the doorphone Controller
      b. This shall be from the exterior interfaces, throughout the system and to the communications room where the doorphone controller shall be located.
      c. Doorphone controller shall connect to the Ethernet network and provide a SIP connection to the owner’s telephone system.
      d. Doorphone controller shall connect to the access control system to support unlocking of the door associated with the Intercom
      e. Provide cabling required for connectivity of this device to the network and access control system
   2. Audio intercoms “IC” at the door shall have the following characteristics:
      a. Device shall have a single, 1-touch, push-button for calling into the telephone system. This shall open a 2-way communications path between devices.
      b. Include the backbox for custom mounting. Provide weatherproof equipment outdoors.
   3. Surface mounted audio intercom with doorphone controller shall be Algo #8028

2.21 BLUE-LIGHT EMERGENCY PHONES
A. Blue light phones shall be VoIP connectivity. TalkaPhone is the approved manufacturer.
B. The following are the components that are approved for Blue Light telephones:

<table>
<thead>
<tr>
<th>Item</th>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIP Phone</td>
<td>VOIP-500E</td>
<td>VOIP-500 Series Call Station with EMERGENCY Signage</td>
</tr>
<tr>
<td>Stanchion Enclosure</td>
<td>ETM-MT/R-QP4P-PCS-001 (001 is the Ramtel Mounting Pattern) ETP-MT/R Series Tower Mount with LED Blue Light, LED panel light, and camera arm with provision for a dome camera (camera not included) and built-in 2.5-inch O.D. post (located at the top of the camera arm) for pole mounting other devices.(e.g. wireless radios) Includes internal shelf and mounting panel. Emergency Phone is purchased separately</td>
<td></td>
</tr>
<tr>
<td>Ramtel Adapter</td>
<td>ADAPT-56-GA-RM</td>
<td>Required if mounting Talkaphone VOIP-500E in existing Ramtel Tower</td>
</tr>
</tbody>
</table>

2.22 WIRES AND CABLES
A. All cables shall be plenum rated

<table>
<thead>
<tr>
<th>Application</th>
<th>Wire Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber converter to Cardkey panel</td>
<td>24 AWG x 4 Pair – Solid Jacketed Copper Plenum CAT – 5</td>
</tr>
<tr>
<td>Fire &amp; Fire Trouble inputs to board</td>
<td>18 AWG x 1 Pair - Solid Jacketed Fire Rated Plenum</td>
</tr>
<tr>
<td>Auto operator or temp probe to board</td>
<td>22 AWG x 4 Cond. w/Stranded Flexible Jacketed Plenum</td>
</tr>
<tr>
<td>Cabinet tamper / glass break reset</td>
<td>22 AWG x 2 Cond. w/Stranded Flexible Jacketed Plenum</td>
</tr>
</tbody>
</table>
PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine all pathways prior to installation of all cables and raceways.
B. Install all conduits, pass-thru’s, raceways and surface mounted raceways prior to installing the security system devices and cabling.

3.02 PREPARATION
A. Locate main path for all cables and install J-hooks where cable tray is not provided.
B. Coordinate with other trades to install a clear, straight path down major corridors for the routing of security/access cables back to the communications closet.
C. Plan installation of cables along wallfield in communications room. Provide finger-duct and D-rings for support of cables. See drawings.

3.03 INSTALLATION-GENERAL
A. Security/access cable shall be installed per industry standards.
1. Install all cabling required for complete system connectivity. Cabling shall be plenum rated.
2. Care shall be taken to avoid crimping or bending the cable past the manufacturer’s recommended bend radius.
3. During installation, the cables shall not be pulled across the ceiling tiles or the structure of the building. This may cause damage to the cable jacket.
4. Adhere to all pulling tensions and bend radii during installation.
5. All cables shall route neatly in the ceiling. Whether they route in cable tray or J-hooks, the cables shall be neat and orderly.
6. Support cables at a minimum of every 5 feet.
7. When routing security/access cables parallel to electrical conduits and lighting ballasts, the cable shall maintain a clearance of at least 12 inches. When running perpendicular to electrical conduits and lighting ballasts the cable shall maintain 6 inches of clearance.
8. Provide a short coil of extra cable where the cable enters the vertical conduit. The coil shall consist of no less than 1-1/2 feet.
9. When installing cables in the communications room, all cable shall route neatly through the cable tray and cable ladder.
10. Provide a service loop of the cables on the wallfield.
11. Each cable shall have a self adhesive, self laminating, laser printed label at each end. The label shall show the location identifier of that cable. Labels shall be installed no more than 4 inches from the termination point of the cable.
B. Firestopping is required at all riser conduits, and all pass thru’s.
   1. Each cable tray penetration of a wall shall be firestopped after cable installation. Use pillow type firestop to allow additional cables to be installed in the future.
   2. Where riser conduits pass through floors, the area between the concrete and the conduit shall be firestopped. This shall be completed with a putty or liquid firestop product. Fill in the space with mineral wool, and then install the firestop on top. All firestop shall be of sufficient thickness to secure the rating required by code.
   3. After final cable installation, install a putty firestop around all cables where they enter and exit conduit pass thru’s and conduit risers.
   4. Firestop as per AHJ requirements.
C. Cabling at the Panel.
   1. Contractor shall coil all spare cable from the door devices outside the security panel and shall neatly coil the cable on the wall. Provide 5’ minimum in the coil for future movement of the panel.
   2. Cables shall route into the panels through a grommeted hole that is sized for the cables entering.
   3. All cables shall be installed in a neat and workmanlike manner.
   4. Cables shall be terminated and shall allow for removal of a card without un-terminating the cables.
   5. All cables shall be neatly distributed to the card in the panel.
   6. All labels shall be visible inside the panel near the termination point. Label cables equidistant from their termination point.
D. Proper support of cables is of paramount importance when installing a cable infrastructure. All cables not in conduit or cable tray shall be supported via J-hooks a minimum of every 5 feet.
   1. Routes of cables shall be parallel or perpendicular to the walls of the building.
   2. Install the J-hooks to minimize changes in the level of the cables as they route through the J-hooks.
   3. All communications shall route as high in the ceiling as possible while still being accessible and staying away from other utilities.
   4. When installing the cable through the J-hooks, they shall all have relatively the same droop between hooks. All cables shall be installed neatly and squarely.
   5. Secure the J-hooks to the building structure with beam clamps and threaded rod as required to support the cables.
   6. J-hooks shall never be attached to drop ceiling support wires. Cables shall never be supported by drop ceiling wires.
E. Raceways.
   1. Shall be mechanically attached to the wall or door.

3.04 SERVER AND SOFTWARE INSTALLATION
A. Management Server:
   1. Server is existing.

B. Control Software:
   1. Contractor shall schedule meetings with the Owner prior to installation to determine the working of the security/access system.
   2. Configuration of the security software shall include but not be limited to the following:
      a. Number each door and any input and outputs associated with that door and associate it with a standard door name for easy review.
      b. Meet with the owner to determine how they will use the system. Take information from them that will allow all custom settings of the software system. This shall include but not be limited to:
         A) User groups based on building and administrative group
         B) Access levels based on groups and times.
         C) Door Groups for access and locking and unlocking schedules.
         D) Building locking and unlocking schedules for each building
         E) Administrative levels and super administrators
         F) Building arming and disarming schedules of door contacts
         G) Alarm level setting for different doors based on time of day and day of week.
         H) Snow-Day override schedule that shall change when doors unlock and lock and which users or user groups are allowed to access the building during a snow day. Snow day shall revert back to regular scheduling after 11 PM that day.
         I) Setup all user logins to allow specific viewing of portions of the system based on login ID.
            1) Detail in the setup that persons rights in working in the system.
      c. Lockdowns and Secure
         A) Create different locking schedules and processes for Lockdowns and Secure situations.
         B) Work with the owner to determine what doors are locked or unlocked in a lockdown or secure situation.
         C) Make all settings and groups required for each situation.
      d. Set all alarm levels and outgoing calling attributes such as central station outcalls, paging and email alerts.
         A) Add users and all those that are to be notified on a building basis.
         B) Set levels for all door contacts such that the owner is notified of a door open when the system is armed but is not alerted during the day unless they ask for this type of configuration.

3.05 CONTROL PANEL INSTALLATION

A. Enclosure and power
   1. Contractor shall mount the enclosure on top of ¾” fireproof plywood.
   2. Mount enclosure in the location noted. Coordinate other equipment and wallfield systems.
   3. Locate the 120 volt power outlet and install enclosure in relation to power.
   4. Size the enclosure to support all PACS devices noted on the drawings and in the specifications.
   5. Provide magnetic cable support devices in the panel to route cables inside the panel to the controllers and power devices.
   6. Power.
      a. Install cabling and raceway to connect the power supply in the enclosure to the 120 volt power outlet.
      b. Shall be hard-wired power. Plug-in power is not allowed.
      c. Provide an electrician for connection of the power supplies if required by AHJ.
   7. Battery backup.
a. Provide and connect the batteries to the power supply for the enclosure
b. Test the battery supports the panel by removing 120 volt power after the system is fully up and operational.

8. Network connectivity
   a. Provide and install CAT-6 cable from the enclosure for the power supply to the communications rack. Connect to the Ethernet switch
   b. Install fiber adapter and connect to the fiber optic patch panel
   c. Ensure connectivity to the WSU network for Police Department monitoring.

9. Other Controllers and I/O Board connectivity.
   a. Provide and install cabling to connect the Ethernet controller to the other controllers and I/O boards via RS-485.
   b. Do not install RS-485 between communications rooms. Each comm room shall have an Ethernet attached Controller.

B. ACP
   1. ACP shall be mounted in the enclosure as shown on the drawings.
   2. ACP shall be sized for all security, access, control, and monitoring points existing on the drawings and shall be expandable.
   3. Controller shall be able to be linked to additional controllers in other communications rooms/buildings via the Ethernet network.
   4. Each port in the controller that is connected to a security point shall be labeled inside the controller box.
   5. Label the outside of the panel with the door numbers and list of devices that are connected in that panel. Shall be laser printed adhesive labels.
   6. Label the inside of the panel door with the layout of the panel and which controllers attach to which devices. Include door numbers on the diagram.
   7. Depending on the type of panel the contractor shall provide cable routing hardware and equipment to neatly install cabling.
      a. Route cable to allow easy change and replacement of the individual control cards in the panel.
      b. Cabling shall be neatly bundled. See example below of adequate cabling being routed into a panel.
   8. Network connectivity
a. Provide and install CAT-6 cable from the controller to the communications rack.  
   Connect to the Ethernet switch
b. Connect on the Ethernet to the Switch.

C. Fire Alarm integration “FA
   1. Wire from the enclosure/controller to the Fire Alarm system
   2. Provide all cabling and i/o ports to accept inputs from the fire alarm or trigger the fire alarm panel.
   3. Work with the fire alarm provider to support integration between the PACS and Fire alarm. That may include:
      a. Release of Hold opens for doors in a lockdown
      b. Release of magnetic locks during a fire alarm event
      c. Release of electronic locks during a fire alarm event.
      d. Others as defined by the owner.

3.06 DOOR LOCKING CONNECTIVITY
A. Latch Retraction device. “LR” on drawings
   1. For wiring in the actual push bar and in the door frame just behind the EPT power transfer.
      a. The contractor shall install Molex receptacle (mfg. part # 03-06-1062) with female pin connectors (mfg. part# 02-06-1103-C) where cable from EPT enters exit device.
      b. Use Molex receptacle (mfg. part # 03-06-2061) with male pin connectors (mfg. part # 02-06-2103-C) on exit device solenoid and switch wires.
      c. EPT wires transmitting power should be doubled up at both frame and exit device side to accommodate high current loads.
   2. Power Supply
      a. LR exit devices are to be powered with Von Duprin PS914-2RS power supply only. Not more than two EL devices shall be connected to a single PS914-2RS.
   3. Von Duprin EPT-10 (Electric Power Transfer) to be used for the transferring of power and data signals from door frame to door.
      a. Use Molex receptacle (mfg. part # 03-06-1062) with female pin connectors (mfg. part# 02-06-1103-C) where cable from door frame meets EPT. Use Molex receptacle (mfg. part # 03-06-2061) with male pin connectors (mfg. part # 02-06-2103-C) on door frame side of EPT wires.
      b. Molex connectors used on exterior door EPT must be lubricated with dielectric lubricant (white petrolatum) and must be wrapped in electrical tape to protect pin connectors and wire from exposure to moisture.
      c. Red and Green wires shall be doubled up for 24 VDC Positive signal
      d. Black and Brown wires shall be doubled up for 24VDC Negative signal
   4. Provide cards in the controller panel and equipment to allow the security system to interface with the LR.
   5. The LR shall be able to be held open based upon a time schedule put forth in the security system. It shall also be able to be retracted upon presentation of a valid card or fob to the card reader.
   6. Wire to the latch retractor and full integrate it into the security system.
   7. Wire from the LR to the Power Supply in the ceiling near the door.
   8. Wire from the power supply to the security panel in the comm room to allow control of each individual door.

3.07 READER INSTALLATION
A. Card Readers “CR” on drawings
   1. Card readers shall be installed at locations shown on the drawings.
   2. Review site and drawings and coordinate the wall mounted readers and frame mounted readers. Order the correct reader for each location.
      a. Conduct a site visit prior to ordering card readers.
b. If the wrong reader is ordered, then the contractor shall provide the correct reader.
3. Coordinate installation of all card readers with the doors and walls.
4. Where the reader is mounted on the door, coordinate the installation with the installation of the door to allow all cable for security/access.
5. Locate all card readers at ADA compliant heights and locations.
6. Wire and configure the card readers so that when the lock is engaged the light on the reader is red and when the door is unlocked the light is green.
7. Garage Doors and Pedestals: At the garage doors and at pedestals the card readers shall be installed with a box that has a cover for the top of the card reader.

3.08 DEVICES AT THE DOOR
A. Door Contacts “DC” and Garage contacts “GC”:
   1. Install contacts where shown on the drawings. For door contacts, install them at the top of the door.
   2. Work with door provider and installer on timing of door contact installation.
   3. Install raceways to allow installation of the door contacts if no raceway is provided inside the wall.
   4. Drill into the door frame and door to allow installation of the door contact and the associated cable. No cable shall be visible after installation.
   5. Where door frames are filled, they shall be drilled out to allow installation of the door contact. Surface mount contacts are not allowed at any student accessible doors.
B. Request to Exit Devices “RX” on drawings
   1. When the RX is shown, wire from this device in the lock/pushbar, back to the controller in the comm room.
   2. Set this up to shunt the door contact when triggered.
C. Door Position switch. “DP”
   1. Wire back to the access control system.
   2. Configure the system to note and use the position of the door to allow or disallow different events
   3. Work with the owner on configuring the system to act, alarm or not allow something based on the door position switch state.

3.09 ASSISTED OPENER FOR ADA
A. Assisted Opener: “AO” and assisted button “AB” on drawings
   1. Where an assisted opener is shown the contractor shall wire to this opener to work as noted on the drawings and as below:
      a. If the person presents a valid card then the latch shall retract inside the exterior door.
      b. The door shall hold unlocked for 15 seconds.
      c. The control board shall allow the exterior push button to be energized. Once the push button is energized then the exterior door shall be opened of the button is pushed.
   3. Operation sequence when the doors are unlocked entering from outside
      a. Push the ADA button Exterior door opens
   4. Operation sequence when the doors are locked entering from outside -no card or invalid card
      a. If the person pushes the exterior opener button, then the auto opener shall not engage because the opener button is not energized.
      b. The exterior opener button is not energized unless the PACS notes that the door is unlocked.
   5. Operation sequence when the doors are locked, exiting from interior
      a. When a person pushes the interior opener button then that shall communicate with the interior auto opener and open that door.
b. The control board of the auto opener shall communicate with the access control system and instruct it to retract the latch on the interior door.

6. Operation sequence when the doors are locked, exiting from vestibule
   a. When a person pushes the vestibule opener button then that shall communicate with the exterior auto opener and open that door.
   b. The control board of the exterior auto opener shall communicate with the access control system and instruct it to retract the latch on the exterior door.

3.10 ALARM DEVICES
   A. The contractor shall connect the alarm devices to the Pegasys
   B. Pegasys shall take input from the alarm devices and trigger an output or event. Work with the owner to setup the event or output.
      1. Output may be one of the following:
         a. Trigger of a light or strobe
         b. SMS message output
         c. Email message to owner defined group of users.
         d. Output to an alarm system.
   C. Glass Break “GB”
      1. Install glass break sensors as noted on the drawings.
      2. Install based on manufacturers recommendations. Wire to PACS controller
         a. Where multiple glass break sensors are located in close proximity to each other, they must be wired to a nearby centrally located junction box.
         b. The glass break sensors must be wired in series with each other to said junction box with a single cable pair wired to the access control/intrusion detection system.
   D. Security Contacts “SC”
      1. Install and attach these to the AV devices.
      2. Leave a spare coil of cable for short movement of the AV device.
      3. Test contact and document test.
   E. Testing
      1. Fully test alarming and outputs of the system with the owners SMS and Email systems and/or the owner’s security office.
      2. Test interaction with the access control system where they are connected.

3.11 INTERCOMS AT THE DOORS
   A. IP Intercoms
      1. Intercom at the door shall be installed based on the type chosen and specified in specs and drawings.
      2. Where the Intercom is surface mounted.
         a. Surface mounted units shall be connected to the interior of the building with a conduit and steel backbox.
         b. Where possible route the cables through the door or wall framing and extend to the intercom.
         c. Install raceway from bottom of intercom to lower pushbutton.
         d. Ensure installation of lower button to meet ADA requirements
      3. The intercom device shall be located at a place where it is accessible and where it can be mounted to see the person calling.
         a. Camera shall be positioned to cover the maximum area possible.
         b. Install a connection cable from the exterior interface to the interior unit and door lock.
         c. Install any baluns, adapters, or other devices required to send the signal from the exterior intercom to the network.
         d. Provide CAT-6 patch cables
      4. IP Programmable Relay (doorphone controller)
         a. This device shall be mounted in the main communications room.
         b. Connect to the Ethernet network with appropriate CAT-6 cabling
c. Connect to the controllers to allow the base station to unlock the associated door.
d. Integrate so that the base station only controls the door that the call was initiated from.

END OF SECTION 28 35 00
SECTION 28 37 00
SECURITY CAMERAS

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. This section includes parts, cameras and equipment required for installation of the video surveillance cameras.
B. This shall include new IP video cameras and their software/configuration equipment as shown on the drawings and detailed in the specifications.

1.02 COORDINATION
A. All cables shall be coordinated with the installation of the raceways.
B. All cameras shall be installed in the ceilings in relation to the lights and other obstructions.

1.03 DESCRIPTION
A. Provide new IP cameras for video surveillance. See the detailed security drawings for location and quantities.
B. Cameras shall be pure IP cameras without the use of external encoders/decoders where possible.
C. Power for interior and exterior cameras shall be provided via the POE switch or via a centralized power supply in the communications room.
   1. The switches installed provide standard Type 3 PoE (15.4 watts) on each port. If a camera requires additional power above Type 3 PoE then the contractor shall provide that power supply and any additional required power cables.
D. PTZ and other cameras that require additional power above that provided from a Type 3 PoE connections shall be provided with a power supply.
   1. Provide any and all camera, power and control cables required for complete system connectivity and functionality.
E. It shall be the Contractor’s responsibility to provide all power to cameras based on the above methods. Take into account the Manufacturers recommendations.

1.04 EXISTING SYSTEM
A. The owner has an existing Video Management System and Storage and processing for the cameras being installed as part of this project.
B. Owner will configure the existing VMS to support the new cameras.

PART 2 - PRODUCTS

2.01 2.01 MANUFACTURERS
A. Approved Manufacturers for IP cameras:
   1. Axis

2.02 CAMERAS GENERAL REQUIREMENTS
A. Cameras shall provide full color images, and some shall change to black and white in low light.
B. Cameras shall support text overlay of image in viewing to allow naming/numbering of each camera on the screen and when video is offloaded.
C. The Contractor shall review the site with the Owner prior to ordering the lens for each camera.
   1. Finalize the needs of the Owner with the camera position to ensure that the correct lens is purchased for the camera.
D. Where noted on the drawings, provide a vandal resistant dome to the camera.
E. Where cameras require more power than PoE 802.af then the contractor shall provide power to the camera from a centralized power supply in the comm. room.

F. External Cameras
   1. Each exterior camera shall be equipped with a heater/blower or other device to keep camera functional and keep lens/casing from fogging or condensation from forming.
   2. Provide mounts for exterior cameras based on their installation location. Provide fully enclosed mounts. See drawings and conduct a field survey prior to ordering to ensure that he correct mounts are provided.
      a. Exterior mounts shall allow cable entry to the dome via the support. No cables shall be exterior to the mount or dome.

2.03 CAMERAS -
A. Cameras shall provide full color images, and some shall change to black and white in low light.
B. Cameras shall support text overlay of image in viewing to allow naming/numbering of each camera on the screen and when video is offloaded.
C. The Contractor shall review the site with the Owner prior to ordering the lens for each camera.
   1. Finalize the needs of the Owner with the camera position to ensure that the correct lens is purchased for the camera.
   2. Purchase the correct mount for each camera. Review the mounts for each camera with the owner prior to ordering.
   3. For drop ceiling locations provide a recessed mount and support all cameras from the T-bar of the grid and not just from the drop ceiling tile.
D. Where cameras require more power than PoE 802.af then the contractor shall provide power to the camera from a centralized power supply in the comm. room.
E. Camera shall be capable of the following:
   1. Plenum-rated backbox for indoor
   2. Weatherproof box for exterior installations.
   3. Wide temperature range for indoor and outdoor.
   4. Adjustable fixed camera mounting bracket that allows 360-degree mounting.
   5. Dome shall be clear exterior, smoked on interior cameras
   6. Power through PoE 802.af
   8. Compatible with the Video Recording System
   9. Minimum frame rate capability shall be 20 frames per second at maximum camera resolution. 30 FPS at all other camera resolutions.
   10. Compression shall be H.264, or motion-JPEG.
   11. Outdoor camera temp range shall be -40F to140F
   12. Some cameras shall have multiple lenses and shall be configurable and aimed as per the owners requirements
F. Cameras shall be as shown on the drawings.
   1. Provide all equipment and mounting for all cameras
   2. Default for exterior camera shall include a mount to extend the camera from the wall and install horizontally.
      a. The owner may ask to have the cameras flat against the wall. Verify with the owner prior to ordering.
   3. Provide a patch cable for each camera. Install and connected.
   4. Label each camera with a number that is approved by the owner. Label shall be visible and legible when standing on the floor, looking at the camera.

2.04 CAMERA ACCESSORIES
A. Camera Mounts:
   1. The Contractor shall provide all appropriate camera mounts. Refer to the drawings and conduct a site survey to determine each camera mounting type required.
      a. Complete this prior to ordering cameras.
      b. Review Reflected ceiling drawings from architect.
2. Exterior cameras will be mounted to the wall of the building in most cases.
   a. Where the camera is to look along the wall of a building the contractor shall provide a pendant mount that mounts the camera parallel to the ground.
   b. Mount shall extend the camera out from the building a few inches to allow viewing in 360 horizontal degrees.

3. The security cameras shall be mounted to building structure where shown on the drawings.
   a. Contractor shall provide a mount that best corresponds to the structure and can be securely mounted.
   b. Mount the camera at a height as shown on the drawings or at the optimum height to allow the best field of view and future service via extension ladder.
      1) Unless specified the cameras on the exterior of a building should not be installed more than 15’ above grade.
   c. When mounting the cameras, take into account the light and mount the camera so that it does not block light.
   d. The camera mount shall provide a route for cables extending from the raceway to the camera. Cables shall not be installed outside the camera dome or camera mount.
   e. The Contractor shall install a conduit to allow cable installation to the camera.
      1) This shall include installing conduits from the inside of the building to the outside of the building to support exterior cameras.
      2) Core through the outside of the building. Coordinate location with owner and architect prior to drilling.
      3) Install ¾ conduit or sized as per the mount.
      4) Except for corner and parapet mounts no conduits shall be visible after installation.
      5) At no time shall a cable be visible. Install flexible conduit and seal appropriately around holes made in the building.
      6) Repair wall after installation.
      7) No cable shall be visible after camera installation.

4. Dome-type cameras interior to a building may be installed in the lay-in ceiling.
   a. Provide supports so that the camera’s weight is supported from the “T” bars of the drop ceiling.
   b. Provide a backbox and escutcheon to make a tight fit from the dome to the drop ceiling tile.
   c. Locate the cameras to cover the area required by the Owner. Work with the Owner prior to installation.

5. Dome-type cameras interior to a building may be installed as a pendant mount from the building structure.
   a. Provide a backbox at the building structure. Install a down pipe and camera mount to attach the camera to the downpipe. Size the pipe as required.
   b. The camera mount shall keep the camera level and shall extend down to a level of no more than 11’ AFF.
   c. Locate the cameras to cover the area required by the Owner. Work with the Owner prior to installation.

6. Dome-type cameras interior to the building may be required to be mounted to a wall.
   a. Where there is a wall mount requirement, the Contractor shall install a wall-mount. Ensure that it is securely mounted.
   b. Route the cable through the wall and through the mount to connect to the camera.

7. Pole mount cameras shall be completely secured to the pole with manufacturer’s specified mounts.
   a. Shall attach to the pole with straps or screws based on the type of pole installed.
   b. Mount shall keep the cable as it routes from the pole to the camera totally enclosed and shall not subject the cable to the weather.
c. When mounting the camera, the cable shall route through the pole. Drill a hole into the pole. Install oxidizing gel around the steel. Then install a rubber grommet.

B. Camera and Power Cable:
1. Cables for transmission of the image and to provide power to the camera shall be plenum-rated.
2. Power cable (if required) shall be sized based upon the power requirements of the camera and other components in the camera, such as PTZ motors and heater.
3. See the drawings for the contractor responsible for installing CAT-6 cabling from the comm room to the camera.
4. The Security contractor shall install all patch cables between the termination of the user CAT-6 cable and the camera as well as the patch cable from the patch panel to the Ethernet switch in the comm. room.

C. All cables shall be supported in the ceiling a minimum of every 5 feet. Support can be provided by installing cable inside cable tray or conduit, or by installing J-hooks every 5 feet.
1. J-hooks shall provide a smooth steel support for cables as they route through the ceiling.
2. Each hook shall have a galvanized finish.
3. Steel, UL listed, ultimate static load limit 50 pounds, rated to support Category-3 and higher cables, and optical fiber cables.

D. Power Supplies:
1. For interior PTZ cameras and external cameras (where PoE Power is insufficient) the power supply shall be centrally located in a communications room.
2. Provide all power supplies and cabling for connection to the electrical circuit.

2.05 CAMERA INSTALLATION ACCESSORIES
A. Firestopping shall be completed inside and around all conduits after cable installation. Contractor shall install the best firestop for each individual installation.
1. Firestop shall be installed with regard to local and national building codes.
2. The firestop shall be a putty-like substance that expands under heat and will not allow flame to pass for a designated period of time.
3. Firestop shall conform to all NEC, NFPA, and UL requirements.
4. Some wall pass-thru’s are shown on the drawings. The Contractor shall utilize these where possible.
5. Where the contractor must install cables through a wall where there is no pass-thru already provided, the Contractor shall be responsible for installing a fire-rated pass-thru and fire-stopping the conduit after cable installation.

B. Weatherproofing shall be completed inside and around all conduits supporting exterior cameras after cable installation. Contractor shall install the best weatherproof for each individual installation.
1. Weatherproof around all conduits that extend through the building to the cameras on the exterior wall or soffit.
2. Seal all cameras so that all camera housing does not allow water into the conduit or into the building.
3. Seal so there is no infiltration of water or condensate.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine all pathways prior to installation of all cables.
B. Identify locations of all user conduits and backboxes prior to cable installation.
C. Review site and note locations of cameras and conduits prior to installation.

3.02 PREPARATION
A. Visit each camera installation location to verify the type of mount prior to ordering the cameras.
B. If another contractor is installing the CAT-6 cabling then the contractor shall coordinate cable location with that contractor.
C. Green Tape walk thru.
   1. Contractor shall walk the entire site with the owner and identify each camera location with the owner prior to installation.
   2. Discuss the type of camera and its proposed field of view.
   3. Make adjustments as required by the owner and by the building structure to minimize interference and blocking of the camera image.
   4. Install a piece of green tape on the wall or ceiling at each camera location after agreement on the location is reached.
   5. Remove green tape after installation of cameras
D. Camera naming spreadsheet.
   1. Create an Excel spreadsheet showing the following:
      a. Camera number
      b. Camera part number
      c. IP address
      d. MAC address
      e. Owners chosen camera name
      f. Provide to the owner and designer.

3.03 INSTALLATION
A. Each camera shall be installed to provide maximum field of view and security.
B. Exterior cameras shall be mounted securely to the structure and shall be sealed to prevent water or any other environmental condition to enter the camera.
   1. Provide the correct mount for the location of each exterior camera.
   2. Where the mount is to the outside of a building then the contractor shall install a conduit from the exterior camera to the inside of the building for the camera cable(s).
   3. Review mounting location to determine optimum height of camera to cover all areas and provide the clearest pictures. Mount at appropriate height.
   4. Work with the Owner to focus and align all cameras for maximum coverage.
   5. Contractor shall change lenses for different focal lengths based on the actual installation location of the cameras and the requirements of the Owner.
   6. Seal around all conduit openings and the camera mount to seal from water and air infiltration.
   7. Install patch cable through the conduit and connect to the CAT-6 cable on the interior of the building.
C. Interior cameras shall be mounted in the lay-in ceiling, supported from the open ceiling or to the wall with a structural mount.
   1. The Contractor shall work with the Owner to determine the location of all the cameras.
   2. Work with the Owner to determine the direction of the lens and its focal length.
   3. Ensure that the camera is mounted securely to the drop ceiling and is supported from the T-bar.
   4. Where interior cameras are mounted to the wall, the Contractor shall provide a mount that will allow all cables to route through the mount. Cables shall not be “free-floating” from the wall to the camera.
   5. When a camera is pendant mounted the contractor shall install a down-pipe and conduit support to mount the camera at the correct height as determined by the owner.
D. Contractor shall focus and aim all cameras
   1. Camera aiming and focusing shall be a process where the owner has input at each stage.
   2. The process for aiming and focusing shall be as follows:
      a. Meet with the owner and determine the desired view of each camera. Determine where images shall overlap and what they are focusing etc.
1) Add this information to the camera naming spreadsheet.

b. Install the cameras and aim as per the meeting notes.

c. Meet with the owner and review each camera view on the monitor. Make notes of any changes required.

d. Schedule a time to make all changes.
   1) Changes shall be made while the owner is reviewing the live image through the VMS Software. The contractor shall have a person at the camera that can aim and focus the camera.
   2) Once the owner agrees on the image aim and focus generate a still picture of that image and keep it in a file.
   3) Print the aimed view and provide as part of the submittal at project substantial completion.

E. Camera naming

1. The contractor shall work with the owner and engineer to determine the naming and numbering convention for the cameras.

2. Determine the naming and then apply that to each camera. Enter the designation of the camera into the video security system.

3. On all cameras the contractor shall affix a label with the camera number to the exterior case of the camera. This shall be visible when standing near the camera.

END OF SECTION 28 37 00
SECTION 28 72 00
TECHNOLOGY SUBMITTALS

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. This section provides the Contractor with requirements regarding Product Data Sheets, Shop Drawings and Product Samples collectively referred to as “Submittals”.
B. This section provides the Contractor requirements regarding As-Built Documentation after installation and prior to Final Completion and Final Payment
C. The requirements of this section deal only with those submittals that are required to be provided by the chosen contractor after bid award. No submittals in this section are required to be provided with the Bid Response.
D. The requirements contained herein should be considered bound and apply to all technology and security specification sections per this contract.

1.02 PRE-INSTALLATION SUBMITTALS
A. The contractor shall provide material submittals to the Construction Manager or directly to the designer, whichever is managing the project.
B. Prior to beginning work, the chosen Contractor shall provide PDF files of all material submittals.
   1. Highlight the part number of each item specifically. Submittals that are not highlighted will be rejected and sent back immediately.
   2. Include an Excel spreadsheet in .xls format to the designer for use in reviewing the submittals. Shall include all part numbers and manufacturers. Match camera submittals with the camera type on the drawings
   3. Provide an Excel Spreadsheet listing the following:

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturer</th>
<th>Part Number</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enet Switch</td>
<td>Rainbos</td>
<td>XR-243T</td>
<td>Cam type “CA”</td>
</tr>
</tbody>
</table>

   4. Provide the PDF with the following file names
      a. Site - Spec Section - Description
      b. In Example: Kent City 28 1600: Data Cabling submittal

1.03 AS-BUILT DOCUMENTATION
A. The contractor shall provide As-Built documentation to the Construction Manager or directly to the designer, whichever is managing the project.
B. Provide the As-BuILts in hard and soft copy
   1. Hard Copy shall include one or more three-ring binders that include all documents listed below. Include a cover page on the front of the binder(s) detailing the client, the project, date of submission and project name/number
   2. Soft copy on USB Drives (PDF or Microsoft Word or Excel) shall include all documents provided in the hard copy plus any configuration or data files. Include XLS files for all spreadsheets.

PART 2 - PRE-INSTALLATION SUBMITTALS

2.01 PRODUCT DATA SHEETS
A. Product data sheets shall consist of the manufacturers detailed specification sheets or “cut-sheets” for each product that is to be installed by the contractor or any subcontractors.
B. Product data sheets shall minimally include, but shall not be limited to:
   1. Part Number
2. Manufacturer
3. Description of the product
4. Physical dimensions and characteristics of the product
5. Picture or manufacturers drawing of the item, where applicable
6. Electrical characteristics of the product including heat-load for active electronics.
7. Optical characteristics of the product for Fiber-Optic equipment and cable.

C. Provide product data sheets for all equipment and cabling that is to be installed by the contractor

2.02 SHOP DRAWINGS
A. Shop Drawings shall consist of detailed drawings showing actual connectivity and cable types for the systems noted below:
   1. Access Control system connectivity
B. Shop drawings shall also be provided for systems that the contractor intends to connect differently than what is shown on the contract drawings or where no connectivity is shown.

2.03 PRODUCT SAMPLES
A. Product Samples shall consist of a sample of the actual product that is to be installed.
B. Samples shall be tagged with the part number and specification section to which it pertains.
C. Product Samples shall be provided for the following:
   1. None at this time.

2.04 SUBMITTAL DOCUMENTS
A. The Contractor shall provide all Submittals to the Construction Manager or the designer
B. The Contractor shall provide PDF and Excel Files for all Product Data Sheets.
   1. All Product Data sheets shall be PDF files grouped via specification section or drawings number
   2. The data sheets in the file shall be segmented to match the specification section and page number they pertain.
   3. The Contractor shall highlight the actual part number on the sheet of the component that they are submitting.
   4. If no part number is highlighted or marked with an arrow, then the entire submittal package will be rejected and sent back for re-submission.
   5. Contractor shall submit an electronic copy of the Excel spreadsheet with their data sheets that details the manufacturer, part number and common name of the products that they are submitting.
C. The Contractor shall provide 1 set of PDF and one hard copy set of Shop Drawings.
   1. Shop drawings shall be marked for the specification section of the bid documents to which they pertain.
   2. All shop drawings that are required to be drawn on the building background shall be provided on full-size drawings the same scale as those in the bid documents.
   3. All lines on the shop drawings shall be highlighted or completed in ink that is not the same color as that provided in the bid documents.
   4. The contractor shall provide a drawing legend detailing all symbols used in creation of the shop drawings.
D. The Contractor shall provide one of each product sample required to be submitted.
   1. Provide a cutsheet with each product sample detailing the specifics of the product and what it is proposed to be used for.

2.05 SUBMITTAL REQUIREMENTS
A. Submittals shall be provided for approval prior to installation of the work.
B. Any equipment installed that does not have an approved submittal associated with it can and will be removed from the project and replaced with other equipment as defined by the Designer. All replacement costs shall be the responsibility of the Contractor.
C. It shall be the responsibility of the Contractor to provide the submittals for review in sufficient time to not delay the installation. Work with the Construction manager on the schedule.

D. It shall be the responsibility of the contractor to ensure they have provided and have on hand “Reviewed” or “Furnish as Corrected” submittals for all equipment they install.

PART 3 - AS-BUILT DOCUMENTATION

3.01 MATERIALS

A. The Contractor shall provide the following to the Designer prior to the issuance of the final payment.
   1. Approved submittals and equipment user manuals.
   2. As-Built Documentation as detailed below.
   3. All spare parts and cover plates for all components of the systems
   4. Manufacturer warranty cards for all components.
   5. (2) spare of each kind of audio and video patch cable installed as part of the project.

3.02 AS-BUILT PROCESS

A. The Contractor shall provide all project as-builts to the designer at substantial completion.
   1. Provide them to the designer for review
   2. Make any required changes the designer requests
   3. Re-submit at the time of Final Completion / final payment. Final Payment is not possible without a complete post installation deliverable package

3.03 PREPARATION

A. All binders for As-Builts and test results shall be neat and clearly labeled with listing of the project and documents included in each binder.

B. Quantity:
   1. Submit one (1) set of three-ring binder(s) with hard paper copies of project closeout submittals.
      a. Provide a clear label or cover sheet with the following information:
         A) Client name.
         B) Project name.
         C) Manual title (e.g., “Project Close-out Manual for security system upgrade”).
         D) Date; date format: <month> <day>, <year> (e.g., “January 1, 20xx”).
         E) Installer and General Contractor names and contact information

3.04 PROJECT DELIVERABLES

A. Provide a copy of all submittals and manuals and pamphlets. Shall be separated by equipment type with dividers in the binders.

B. All spare parts shall be provided in a box. The Contractor shall detail which component each spare part is for.

C. The contractor shall provide one set of full sized as-built prints. Provide a PDF of the as-built prints on the USB drives.
   1. Provide a clean set of the latest drawings with red lines marked for all field changes or bulletins.

D. The As-Built drawings shall include:
   1. Changes to be reflected on the drawings for Video Security Systems shall include:
      a. Camera locations
      b. Cabling Paths
      c. Camera numbers
      d. Comm room where camera connects to.
2. Changes to be reflected on the drawings for Access Control/Alarm Systems shall include:
   a. Changes to hardware installed at each door. Update each door for all devices installed and connected
   b. Changes to the panel locations
   c. Door numbers
   d. Changes to the schematic connectivity of any system shown on the drawings.

E. Documentation for the specific systems shall include. Provide the following for each system:
   1. Contractor warranty dates based on Substantial completion date and contact information for warranty work.
   2. Video Security
      a. Picture of focused and approved camera image labeled with the camera number and IP address
      b. Master user password list
      c. Spreadsheet of each camera that shall include:
         A) Camera Part number
         B) Firmware revision
         C) IP address
         D) MAC Address
         E) Camera Name
         F) Building where it is located
      d. Training “Cheat Sheet”
      e. Manufacturers Camera Warranty
      f. Server/NVR Warranty
      g. Manufacturer contact information for warranty work
      h. Software Upgrade Protection (SUP) warranty including end date
      i. Warranty certificate for all PC’s
   3. Access Control
      a. Part list/diagram for each access control panel. To include
         A) Panel name and IP address (if applicable)
         B) Doors which are connected to this panel
         C) Panel location. Building and room number
      b. Diagram showing which devices and doors that are attached to each panel
      c. Training “Cheat Sheet”
      d. Server Warranty
      e. Software Upgrade Protection (SUP) warranty including end date
      f. Warranty certificate for all PC’s

END OF SECTION 28 72 00
SECTION 28 76 00
TECHNOLOGY LABELING

PART 1 - GENERAL

1.01 WORK INCLUDED
   A. This section provides direction on labeling of cables and devices.

PART 2 - PRODUCTS

2.01 CABLE LABELING PRODUCTS INTERIOR
   A. CAT-6 and access control
      1. Laser-printed, self-adhesive wrap around shall be Brady LAT-18-361 or equivalent.
      2. Label shall be 1.00-inch width x 1.33 inch high.
      3. Labels shall come on a sheet with 7 labels per row with a white and transparent matte finish.
      4. Sheet size shall be 8-1/2 inch x 11 inch.
      5. Printable area shall be a minimum of 1.00-inch width x 0.50 inch high.
      6. All labels shall be printed through a laser printer using labeling software.
      7. The Contractor shall submit a proposal for the labeling scheme for all audio and video wiring. The Engineer shall approve of the scheme prior to all labeling.

2.02 SECURITY CAMERA LABELING
   A. Laser-printed, labels shall be used to label all Security Cameras
      1. Label the camera with a White or Clear label with black lettering.
      2. Label shall include the camera number.
      3. May include the IP address. Consult with owner to determine if this is required
      4. Label shall be a minimum of 3/4 inch tall and legible when standing beneath or near the camera as long as camera is not above 15; AFF

2.03 ACCESS CONTROL PANEL LABELING
   A. Label the front of each access control panel to detail the doors that are connected to the panel.
      1. Label the front panel and detail each door number
      2. Label shall include the panel name and IP address
      3. Text shall be a minimum of 3/8 inch tall
      4. White label with black numbers

PART 3 - EXECUTION

3.01 PREPARATION
   A. Terminate all cables in proper color code sequence.
   B. Clean any surfaces where an adhesive label is to be installed.
   C. Prior to beginning the work, the contractor shall submit to the engineer a plan for labeling all the cables. This shall take into account to what components each cable is connected.

3.02 GENERAL LABELING
   A. Everything shall be labeled as per the specs and drawings.
   B. All labels shall be installed to more easily identify the cables and ports on all panels. If there are any questions regarding labeling, contact the Engineer prior to installation.
C. Engraved lamacoid labels shall be provided and installed whenever there is no location for paper inserts on faceplates, power poles, poke thru's, floor boxes, modular furniture and surface raceway.
   1. Engraved lamacoid labels shall provide the same labeling as the paper inserts, but they shall be self-adhesive.
   2. These labels shall be adhered to the location closest to the modular jack.
   3. Individual letters shall be provided for each cable. An overall location identifier can be provided for all the cables at that faceplate or floor box.
   4. Engraved labels for rack shall be at least 1-1/2-inch-high with letters 1 inch high.
   5. These labels shall be affixed to the top and front of each rack or cabinet. Verify that the label will fit the rack or cabinet prior to purchasing.

3.03 VIDEO SECURITY LABELING
A. Cameras shall be labeled with the camera number in a visible location.
   1. Affix a label to the camera housing that details the camera number
   2. Shall be in a location that is visible from a standing position.
   3. Shall be laser printed.
   4. Label the camera cable patch panel to include the number of each camera connected to that cable. This camera cable label at the patch panel shall be by video security contractor
      a. Install an adhesive sticker below the cable in the patch panel as the factory number (1-24) is most likely on top of the panel.
B. Label the CAT-6 Patch Panel for security Cameras in each comm room
   1. Install an adhesive label on each port on the patch panel that attached so the security camera cable.

C. CAT-6 Patch panels for security cameras shall be labeled for the camera number
   1. See below diagram:
      a. Install labels at each end detailing the panel number.

<table>
<thead>
<tr>
<th>Panel A</th>
<th>01</th>
<th>02</th>
<th>03</th>
<th>04</th>
<th>05</th>
<th>06</th>
<th>07</th>
<th>08</th>
<th>09</th>
<th>10</th>
<th>11</th>
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<tbody>
<tr>
<td></td>
<td>101</td>
<td>102</td>
<td>107</td>
<td>108</td>
<td>201</td>
<td>105</td>
<td>208</td>
<td>145</td>
<td>146</td>
<td>147</td>
<td>174</td>
</tr>
</tbody>
</table>

D. All labels shall be installed to more easily identify the cables and ports on all panels. If there are any questions regarding labeling, contact the Engineer prior to installation.

3.04 ACCESS CONTROL SECURITY LABELING
A. Security Panels shall be labeled on the outside to indicate panel number and communications room number

<table>
<thead>
<tr>
<th>Security panel</th>
<th>IP address 111.111.10.112</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel 04</td>
<td>Comm room XXX</td>
</tr>
</tbody>
</table>

   1. Install a label on the inside of the panel that details:
      a. Door numbers that are connected to this panel
      b. Diagram of panel showing where each door is connected to the panel.
      c. Panel name as shown in the access control system
      d. IP address of the panel
B. Access Control cables shall be labeled.
   1. The cables at the door devices shall be labeled where they connect to the device at the door
   2. The cables at the panels in the communications rooms shall be labeled with the door number
3. Cable labels shall be installed within 3 inches of the end of the cable sheath.
   a. The cable label shall be similar to the label below:

   | 125A-DC |
   | 125A-DC |
   | 125A-DC |

   b. Provide a sample label to the Engineer for approval prior to installation of all labels.

   125A-DC

   The 125A stands for the Door Number.
   The DC stands for Door Contact. This could be any of the field devices: RX, ES, EL, MX, KP etc.

END OF SECTION 28 76 00
SECTION 28 77 00
TECHNOLOGY TESTING

PART 1 - GENERAL

1.01 WORK INCLUDED
   A. This section provides direction on
      1. Testing of copper and fiber cable,
      2. Testing and commissioning of the technology systems

PART 2 - PRODUCTS

2.01 PUNCHLIST PROCESS
   A. The contractor shall be required to go through a punchlist process prior to substantial completion and final completion/payment of each project
   B. Contractor shall be responsible for reviewing their own work and checking to ensure it has met the project requirements.
   C. The contractor shall:
      1. Review your work in each room
      2. Review the specifications and drawing and review their work to ensure it meets requirements
      3. Create a punchlist document showing what work is not yet done and what as-builds are yet to be completed. Send document to designer.
         a. Provide a date when contractor punchlist work will be completed.
      4. Schedule a punchlist and substantial completion meeting with designer.
      5. Present updated punchlist document to the owner
      6. Walk the site with the contractor and demonstrate all systems and review the work completed. Demonstrate how all work is completed
   D. Designer will create an "Owner Punchlist" document
      1. This will be provided to the contractor
      2. Contractor shall review the list, fix/upgrade/replace all equipment and cabling and finish work on the punchlist
      3. Return punchlist to the designer showing when the work was fixed/completed and a signature on the sheet showing that the contractor has reviewed each item.
   E. Meet onsite with the designer to review the finished work.

PART 3 - EXECUTION

3.01 EXAMINATION
   A. Testing shall be completed after fiber is installed inside the fiber patch panel and the fiber panel has been put together.
   B. All cables and panels where cables terminate shall be labeled with the cable label or name of each individual cable. Identify how each cable and panel will be labeled.

3.02 SECURITY SYSTEM COMMISSIONING
   A. After all Work is completed, and prior to requesting the Acceptance test, Contractor shall conduct a final inspection, and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.
   B. Contractor shall submit a request for the Acceptance test in writing to the owner no less than fourteen days prior to the requested test date. The request for Acceptance test shall be
accompanied by a certification from Contractor that all Work is complete and has been pre-tested, and that all corrections have been made.

C. During Acceptance test, Contractor shall demonstrate all equipment and system features to the owner. Contractor shall remove covers, open wiring connections, operate equipment, and perform other reasonable work as requested by the owner.

D. If the contractor has submitted all necessary paperwork and the system seems to be in working order according to the engineer, then the system can be considered Substantially Complete after the engineer puts that in writing.

E. Security System Substantial Completion.

1. The access control system shall be considered substantially complete as soon as:
   a. All doors are connected, configured in the system and are working as required.
   b. All security devices are connected and have been tested and shown to be fully functional. All cables are labeled at each end.
   c. Intercoms are functioning and able to release lock on a door.
   d. All users are entered into the system and all cards/fobs have been distributed.
   e. All locking and unlocking schedules are defined and are working.
   f. User accounts are setup.
   g. As-built drawings have been updated to reflect any changes in the connectivity.
   h. All manufacturer literature has been turned over to the Owner.
   i. Maps are setup and populated in the system.
   j. Training has been completed.
   k. Copy of the system configuration has been provided to the owner via a CD or thumb drive.

2. The video security system shall be considered substantially complete as soon as:
   a. All cameras are connected and functional.
   b. The system is fully configured and recording images as required.
   c. User accounts are setup.
   d. As-built drawings have been updated to reflect any changes in the connectivity.
   e. All manufacturer literature has been turned over to the Owner.
   f. Maps are setup and populated in the system.
   g. Training has been completed.

3. The contractor shall schedule a substantial completion meeting where all security systems shall be demonstrated and shown to be in working order and configured as per the specs and the owner’s requirements.
   a. If the system is deemed to be in working order then the engineer shall sign a letter stating that the systems are Substantially Complete. The system is not Substantially Complete until a letter is provided to the contractor and owner.

4. After substantial completion the systems shall be in good working order for a period of 30 days.
   a. In the event that the system or systems should fail or not work as required during the 30-day period, the Contractor shall be on site the same day to fix and configure the system to make it work as designed.
   b. A new 30-day period will begin as soon as the system has been demonstrated to be in good working order and the engineer acknowledges in writing that the system has been fixed and is again considered substantially complete.

5. Once the system has been considered Substantially Complete and has been working for 30 consecutive days with no interruption in service, the system shall be thought of as “Finally Complete.”

6. Warranty shall begin immediately after the system is deemed Finally Complete.
SECTION 28 78 00
TECHNOLOGY WARRANTY

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. This section includes directions for the Contractor regarding system and equipment warranties.

1.02 SYSTEM DESCRIPTION
A. The project is not complete until all paperwork has been provided.
B. The Contractor shall warranty his work and all the products installed for a minimum of 1 year from day of Substantial Completion.

1.03 COORDINATION
A. Coordinate as-built drawings and records with the Engineer and Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Provide manufacturers’ warranty for all equipment installed
B. Provide contractor warranty for workmanship and equipment
C. Provide software upgrade protection (SUP) warranty as detailed in the specifications.

2.02 MATERIALS
A. The Contractor shall provide the following to the designer at Substantial Completion and any updates prior to the issuance of the final payment
   1. Manuals and pamphlets on all electronic equipment.
   2. All spare parts and cover plates for all components of the network.
   3. Red lined set of as-built drawings for the entire project.
B. Updated hard copy and soft copy of the As-Built Documentation. See associated spec section.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Contractor shall fully examine all components of the system to make sure that all manuals and paperwork are included in the final submittal.

3.02 GENERAL WARRANTY
A. The Contractor shall warranty the installation and all the parts contained therein for a period of not less than 1 year after receipt of a completely signed copy of the Notice of Substantial Completion.
B. This shall include each and every part, cable or software system provided as part of this project. This includes cabling, Networking, Wireless, Audio/Video systems and Access Control and Video Security systems.
   1. If any part is broken due to a manufacturing defect or installation defect, the Contractor shall fix and/or replace the broken item at their own expense.
2. If any equipment loses connectivity or fails for any reason the contractor shall be onsite to diagnose and fix or replace equipment and upgrades software.
3. The Contractor shall also supply all configuration and programming necessary to keep all electronic equipment to the latest revision of software during the year.
4. If the “system” goes down, and needs configuration to be brought back up, the Contractor shall be liable for any programming or reconfiguration.
5. During the year, the Contractor shall make the Owner aware of any software upgrades that are available.
6. Contractor shall install all software upgrades for that year or as detailed below for specific systems.
7. If the system does not run well during the year the contractor shall be onsite to diagnose and fix the system.

C. The contractor shall be onsite within 24 hours after a call from the owner or designer regarding system or equipment issues.

END OF SECTION 28 78 00
Project Manual for
Wayne State University
Gateway Theater Complex
Vol. 4
Detroit, Michigan
WSU Proj. No. 189-178578
HAA Proj. No. 2016034.00

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Design Architect / MEP Engineer
HGA
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Issued for PERMIT SET
29 JUNE 2020
1.1 DESIGN PROFESSIONALS OF RECORD

ARCHITECT  Hamilton Anderson

PLUMBING/ HVAC  HGA

ELECTRICAL ENGINEER  HGA
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**END OF SECTION**
SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

A. This Section includes the following:

1. Protecting existing trees, shrubs and other vegetation to remain.
2. Removing existing trees, shrubs and other vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above-grade and below-grade site improvements.
6. Disconnecting, capping or sealing, and abandoning site utilities in place or removing site utilities.
7. Temporary erosion and sedimentation control measures.

B. Related Sections include the following:

1. Division 31 2000 Section “Earth Moving” for soil materials, excavating, backfilling, and site grading.
2. Division 32 9200 Section “Turf and Grasses” for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.
1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site unless otherwise noted on the plans.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, according to Division 01 Sections.
   1. Identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Sections.

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract. Contractor is to confirm that this authority has been obtained before beginning work on adjoining property.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.
PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 2000 Section “Earth Moving.”

1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site. Contractor is responsible for doing an independent earthwork computation and including all necessary import and/or export of materials in their bid.

2. Per plan notes, all backfill under and within a 1-on-1 influence of paved areas shall be Class II sand, compacted to 95% of maximum density.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction. If said points will be disturbed, establish new points prior to removal.

B. Locate and clearly flag trees and vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction and the sediment and erosion control drawings, whichever is more stringent.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls only after all areas are restored and stabilized.

3.3 TREE PROTECTION

A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within fenced area.

2. Do not permit vehicles, equipment, or foot traffic within fenced area.

3. Maintain fenced area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.
C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

   1. Cover exposed roots with burlap and water regularly.
   2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
   3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
   4. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

3.4 UTILITIES

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

   1. Notify Architect not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.

B. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.

   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
   3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
   4. Use only hand methods for grubbing within tree protection zone.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

   1. Stockpile topsoil material in locations approved by the Owner or Architect.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

   2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

A. Disposal: Remove surplus soil material, obstructions, demolished materials, other vegetation and waste materials including trash and debris, and legally dispose of them off Owner's property.

   1. Burning of materials on project property is prohibited.

END OF SECTION 311000
SECTION 311012 - FINE GRADING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Attention is directed to Bidding and Contract Requirements, and General and Supplemental Requirements which are hereby made a part of this section.

B. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

A. Work included: All labor, materials, necessary equipment and services to complete the Fine Grading work, as indicated on the drawings, as specified herein or both, except as for items specifically indicated as not in contract on the plans.

B. Related work specified elsewhere:
   1. Division 31 2000 Section “Earth Moving.”
   2. Division 32 9200 Section “Turfs and Grasses.”

1.3 SITE INSPECTION

A. The Contractor shall visit the site and acquaint himself with all existing conditions. The Contractor shall be responsible for his own subsurface investigations, as necessary, to satisfy requirements of this Section. All subsurface investigations shall be performed only under time schedules and arrangements approved in advance by the landscape Architect or Owner’s Representative.

1.4 UTILITIES

A. Before starting site operations verify that the earlier Contractors have disconnected all temporary utilities which might interfere with the fine grading work.

B. Locate all existing, active utility lines traversing the site and determine the requirements for their protection. Preserve in operating condition all active utilities adjacent to or transversing the site that are designated to remain.

C. Observe rules and regulations governing respective utilities in working under requirements of this section. Adequately protect utilities from damage, remove or relocate as indicated, specified or required. Remove, plug or cap inactive or abandoned utilities encountered in excavation. Record location of active utilities.

D. Contact “Miss Dig” for existing utilities survey confirmation.

1.5 QUALITY ASSURANCE

A. Requirements of all applicable building codes and other public agencies having jurisdiction upon the work.

B. Primary emphasis should be given to the aesthetic appearance and functioning of berms and swales, as directed by the Landscape Architect or Owner’s Representative. The Contractor shall
employ skilled personnel and any necessary equipment to insure that finish grading is smooth, aesthetically pleasing, drains well and is ideal for receiving sod and plant materials.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Existing Soil:

1. Strip existing topsoil for new construction unless otherwise directed by Owner's Representative, free from debris, sod, biodegradable materials and other deleterious materials. The Contractor shall insure that all existing soil has sufficient percolation and surface drainage to support grasses and plant material and that extreme compaction occurs only in areas to receive paving.

2. In areas to receive seed, verify that soil is scarified to depth of 3 inches and that soil contains enough organic matter to support and encourage rooting of seeded lawn.

PART 3 - EXECUTION

3.1 EXAMINATION

B. Job Conditions

1. Dust control: Use all means necessary to prevent dust from construction operations from being a nuisance to adjacent property owners and from damaging finish surfaces on adjacent building, paving, etc. Methods used for dust control are subject to approval by the Architect or Owner's Representative.

2. Burning: On-site burning will not be permitted.

3. Protection: Use all means necessary to protect curbs, gutters, sprinklers, utilities and vegetation designated to remain, and, in the event of damage, immediately make all repairs, replacements and dressings to damaged plants necessary to the approval of the Landscape Architect. Contractor shall incur all cost for the replacement of damaged objects and vegetation.

3.2 SCHEDULING

A. Schedule all work in a careful manner with all necessary consideration for adjoining property owners and the public.

B. Coordinate schedule with other Contractors to avoid conflicts with their work.

3.3 EXCAVATION

A. Excavate where necessary to obtain subgrades, percolation and surface drainage as required.

B. Materials to be excavated are unclassified.

C. Remove entirely any existing obstructions after approval by the Architect's or Owner's Representative.

D. Remove from site and dispose of debris and excavated material not required.
3.4 GRADING

A. The Contractor shall establish finished grades as shown on the construction plans and as directed by the Architect, including areas where the existing grade has been disturbed by other work. All disturbed areas are to be restored to their original grades.

B. Finished grading shall be smooth, aesthetically pleasing, drain well and ready to receive sod and other plant material to full satisfaction of the Owner's Representative, Architect and Construction Manager.

3.5 COMPACTION

A. Compact each layer of fill in designated areas with approved equipment to achieve a maximum density at optimum moisture, AASHTO T 180 - latest edition.

1. Under buildings, roadways, curbs, walks and other paved areas: compaction shall be to 95% of maximum density.

2. Under landscaped area, compaction shall not exceed 85% of maximum density.

B. No backfill shall be placed against any masonry or other exposed building surface until permission has been given by the Owner's Representative, and in no case until the masonry has been in place seven days.

C. Compaction in limited areas shall be obtained by the use of mechanical tampers or approved hand tampers. When hand tampers are used, the materials shall be deposited in layers not more than four inches thick. The hand tampers used shall be suitable for this purpose and shall have a face area of not more than 100 square inches. Special precautions shall be taken to prevent any wedging action against masonry or other exposed building surfaces.

3.6 CORRECTION OF GRADE

A. Bring to required grade levels areas where settlement, erosion or other grade changes occur. Adjust grades as required to carry drainage away from buildings and to prevent ponding around the buildings and on pavements.

B. Remove all rock or objectionable material larger than 1 inch in any direction prior to commencing landscaping.

C. Contractor shall be responsible for stabilizing grades by approved methods prior to landscaping, and shall be responsible for correction of grades as mentioned above, and clean up of any wash outs or erosion.

END OF SECTION 311012
SECTION 311018 - SOIL EROSION CONTROL

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

A. The work under this Section includes, but not limited to all work necessary for effective soil erosion control in conformance with Part 91, Act 451, PA 1994, the Soil Erosion and Sedimentation Control Act, Michigan Department of Natural Resources Environmental Protection Act guidelines and all pertinent local enforcing agency rules and regulations, having jurisdiction.

B. Related Sections include the following:

1. Division 31 2000 Section "Earth Moving."

1.3 STANDARDS

A. General: Perform all work under this Section in accordance with all pertinent rules and regulations, including, but not necessarily limited to those mentioned above and these Specifications.

B. Conflicts: Where provisions of pertinent rules and regulations conflict with these Specifications, the more stringent provisions shall govern.

PART 2 - PRODUCTS

2.1 SEED, FERTILIZER, MULCH

A. Refer to other Specification Section in Part 3.

PART 3 - EXECUTION

3.1 GENERAL

A. Standards: Provide all materials and promptly take all actions necessary to achieve effective erosion control in accordance with the Soil Erosion and Sedimentation Control Act, Michigan Department of Natural Resources guidelines, local enforcing agency guidelines and these Specifications.

B. Site evaluation: Prior to start of the Work, conduct a field evaluation of the site along with representatives of the Engineer/Architect and the local enforcing agency.
C. Permits: Soil erosion permit is not required on either project due to limited disturbance area.

3.2 SEEDING AND MULCHING

A. General

1. All bare soil, unless otherwise required by the Contract Documents, shall be seeded, fertilized and mulched to create a protected condition. Use seed mix as indicated on the plans (if different seed mixes are indicated on the civil and landscape plans, the mix indicated on the landscape plans shall override). Critical areas shall be sodded as approved by the Engineer/Architect and as shown on the plans.

2. Seeding and mulching shall be performed immediately upon completion of a phase or section of the Work or as approved by the Engineer/Architect.

3. In all cases, seeding and mulching shall be performed within thirty (30) calendar days from the time the area was first disturbed.

4. During any period of time which the soil is unprotected, provide erosion control structures as necessary to minimize erosion and to keep any eroded soils on the site and out of ditches, rivers, storm sewers and wetlands.

5. Refer to the plans for notes regarding the use of turf reinforcement matting and/or mulch blankets (on all slope exceeding 1 vertical to 10 horizontal).

B. Seed: Seed shall be applied uniformly at a minimum rate of 48 pounds per acre.

C. Fertilizer: Fertilizer shall be applied uniformly at a minimum rate of 250 pounds per acre.

D. Mulch: Mulch shall be uniformly applied at a rate of two (2) tons per acre, or equal, on all seeded areas that have a slope of less than 1 vertical to 10 horizontal. Refer to note A5. above for additional slope stabilization requirements.

3.3 STEEP SLOPES

A. Emulsion

1. On slopes greater than 10%, but not immediately adjacent to a stream or ditch, use erosion control blankets or turf reinforcement matting to hold seed in place. Refer to plan notes.

3.4 SITE IMPROVEMENTS CONSTRUCTION

A. During construction of the site improvements conform to the following general rules:

1. Minimize the amount of earth disturbed at any one time.

2. Establish a construction sequence which includes adequate erosion control.

3. Provide ground cover, even if only temporary, so as to stabilize an area and minimize erosion.

4. As much as practicable, direct storm water away from the construction area. Direct diverted storm water to any stable area.

5. Collect runoff from the site in sediment basins, traps or through filters.

6. Establish an inspection and maintenance schedule, paying special attention to the beginning of the various stages of construction. Employ a certified storm water operator and keep a log of the soil erosion and sedimentation control measures in accordance with the NPDES requirements.
7. Keep in mind that the primary objective is to keep the soil on the site.
8. Once final stabilization of the site is complete, and the governing agency has granted its approval, remove all temporary erosion control structures.
9. Control site runoff during all periods of site construction to ensure that excess surface runoff does not reach adjacent properties. This is especially critical during stages when the land has been stripped but not yet graded.

3.6 CLEANING

A. Perform cleaning of all areas affected by work under this section and leave the site in a neat and tidy state. Contractor shall keep Adjacent Roads clean and free of debris.

END OF SECTION 311018
SECTION 312000 - EARTH MOVING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All earthwork operations shall conform to the current Michigan Department of Transportation standards and specifications.

C. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

A. This Section includes the following:
   1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns, and plantings.
   2. Subbase course for concrete walks and pavements.
   3. Base course for asphalt paving.

B. Related Sections include the following:
   1. Division 31 1000 Section "Site Clearing" for site stripping, grubbing, removing topsoil, and protecting trees to remain.
   2. Division 32 9220 Section "Topsoil (Landscaping)" for finished and fine grading, including placing and preparing topsoil for lawns and plantings.

1.3 DEFINITIONS

A. Backfill: Soil materials used to fill an excavation.

B. Base Course: Layer placed between the subbase course and asphalt paving.

C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.

F. Engineered Fill: Fill placed and compacted to densities specified herein, in a controlled manner using lift thickness limited herein, monitored and tested by the Testing Agency or independent Geotechnical Inspector.

G. Excavation: Removal of material encountered above subgrade elevations.

H. Fill: Soil materials used to raise existing grades.
I. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material 3/4 cu. yd. (0.57 cu. m) or more in volume.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

K. Subbase Course: Layer placed between the subgrade and base course for asphalt paving, or layer placed between the subgrade and a concrete pavement or walk.

L. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

M. Undercutting: Necessary excavation of poor quality soils which occur below the existing Topsoil and any uncontrolled fill soils as described in the Geotechnical Investigation.

N. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Drainage fabric if required for the project.
   2. Separation fabric if required for the project.

B. Test Reports: Testing Agency shall submit the following reports directly to the architect and shall copy the contractor:
   1. Analysis of soil materials, whether procured on or off site, and including fill, backfill, and borrow materials.
   2. Verification of each footing subgrade.
   3. In-place density test reports.
   5. Compressive strength or bearing test reports.

C. Material Test Reports: Interpreting test results for compliance of the following with requirements indicated:
   1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.

1.5 QUALITY ASSURANCE

A. Testing Agency Services
   1. The Owner will secure and pay for the services of a qualified, independent geotechnical engineer to classify existing soil materials, to recommend and to classify proposed borrow materials when necessary, to verify compliance of materials with specified requirements, and to perform required field and laboratory testing. Geotechnical engineer shall be acceptable to the architect and the owner and shall be licensed to practice in the state in which the project is located.

B. Pre-excavation Conference: Conduct conference at Project site to comply with requirements in Division 01 3100 Section "Project Management and Coordination" for meetings.
1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect or Owner and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect and Owner not less than three (3) calendar days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's or Owner's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 – PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials without additional cost to Owner when sufficient satisfactory soil materials are not available from excavations. Contractor is responsible for doing an independent earthwork calculation and including any import of appropriate fill material required to bring the site to the proposed grades.

B. Satisfactory Soil Material (ASTM D 2487): Free of stones larger than 2 inches in any dimension, trash, debris, organic material, other objectionable material and classified as follows:

1. GP (poorly graded gravel).
2. GM (silty gravel).
3. GC (clayey gravel).
4. SW (well-graded sand).
5. SP (poorly graded sand).
6. SM (silty sand).

C. Unsatisfactory Soil Material (ASTM D 2487):

1. SC (clayey sand).
2. CL (lean clay).
3. ML (silt).
4. OL (organic clay).
5. OL (organic silt).
6. CH (fat clay).
7. MH (elastic silt).
8. OH (organic clay).
9. OH (organic silt).
10. PR (peat).

D. Backfill and Fill: Satisfactory soil materials.

E. Subbase: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; Generally either an MDOT Class II sand or 21AA gravel will meet this requirement.
F. Base: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; Generally either an MDOT Class II sand or 21AA gravel will meet this requirement.

G. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; Generally either an MDOT Class II sand or 21AA gravel will meet this requirement.

1. Clean granular fill meeting MDOT Class II grading requirements.
2. On-site granular deposits within the excavation can be used as engineered fill if approved by the geotechnical engineer and if selective excavation procedures are employed to manage existing clay deposits.
3. Import fill as required to make-up volumes necessary to raise the building site.

H. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; Generally either an MDOT 3G, 5G, 6A, or 34R will meet this requirement. Bedding requirements of the agencies having jurisdiction over the utility installation take precedence over these specifications.

I. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; Generally either an MDOT 6A or 34R will meet this requirement. Refer to the plans for specific requirements.

J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Drainage Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; with minimum properties determined according to ASTM D 4759 and referenced standard test methods.

B. Separation Fabric: Woven geotextile, specifically manufactured for use as a separation geotextile; made from polyolefins, polyesters, or polyamides; with minimum properties determined according to ASTM D 4759 and referenced standard test methods.

PART 3 – EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion-control measures approved by agency having jurisdiction to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2 DEWATERING
A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
   2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Explosives are prohibited for use on the Project site.

3.4 EXCAVATION, GENERAL

A. General: Excavation includes the removal of any materials necessary to achieve the required subgrade elevations and includes reuse or disposal of such materials.

B. Unnecessary Excavation: The expense of excavation of materials outside of limits indicated or ordered in writing by the architect and the correction thereof to the satisfaction of the architect shall be borne by the contractor.
   1. Unnecessary excavation under footings: Either deepen footings to bear on actual subgrade elevation without changing top elevations or place concrete fill up to required elevation, as required by the architect.
   2. Unnecessary excavation other than under footings: Either place compacted fill or otherwise correct conditions, as required by the architect.

C. Approval of Subgrade: Notify the Testing Agency when required elevations have been reached.
   1. When required by the architect due to the unforeseen presence of unsatisfactory materials or other factors, perform additional excavation and replace with approved compacted fill material in accordance with the architect’s or geotechnical engineer’s instructions.
   2. Payment for unforeseen additional work will be made in accordance with established unit prices or, if none, in accordance with provisions for changes in the work. No payment will be made for correction of subgrades improperly protected against damage from freeze-thaw or accumulation of water, or for correction of otherwise defective subgrades.

D. Excavation Stabilization: Slope faces of excavations to maintain stability in compliance with requirements of governing authorities. Do not use shoring and bracing where faces can be sloped.

E. Provide appropriate support and protection for deep excavations in close proximity to buildings.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.

C. Trench Bottoms: Excavate and shape trench bottoms in accordance with the plans and standard details. Excavate trenches a minimum 4 inches (100 mm) deeper than bottom of pipe elevation to allow for bedding course (excavate deeper as required by the regulating agency). Hand excavate for bell of pipe. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches a minimum 4 inches (100 mm) deeper than bottom of pipe elevation to allow for bedding course (excavate deeper as required by the regulating agency). Hand excavate for bell of pipe. Remove projecting stones and sharp objects along trench subgrade. Provide bedding course per the plan notes and/or details.

3.6 SUBGRADE PREPARATION AND INSPECTIONS

A. Perform mass earthwork operations to remove all existing topsoil and other organic materials in their entirety within the footprint of the proposed building and pavement areas. Buried objects should be removed in their entirety.

B. Notify Testing Agency when excavations have reached required subgrade elevations.

C. Proof-roll subgrade in the presence of the Testing Agency to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction repeating proof-rolling in direction perpendicular to the first direction. Limit vehicle speed to 3 mph.
2. Proof-roll subgrade with heavy pneumatic-tired equipment or loaded 10-wheel, tandem-axle truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Testing Agency, and replace with engineered fill as directed.

D. If Testing Agency determines that unsatisfactory soil is present, continue excavations and replace with compacted backfill or fill materials as directed.

1. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used at no additional cost to the Owner.

3.8 STORAGE OF SOIL MATERIALS
A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Inspecting and testing underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.10 UTILITY TRENCH BACKFILL

A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

B. Place and compact initial backfill of subbase material, free of particles larger than 1 inch (25 mm), to a height of 12 inches (300 mm) over the utility pipe or conduit. All pipe backfill to be done according to the details shown on the plans or the requirements of the regulating agency.

C. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.

3.11 FILL

A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

C. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material as long as the geotechnical engineer deems the material to be suitable and the compaction requirements can be met.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Behind walls, use engineered drainage fill.
6. Under footings and foundations, use engineered fill.
7. Over excavated areas, use engineered fill or lean concrete.
3.12 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within two (2) percent of optimum moisture content.

1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

3.13 COMPACTION OF BACKFILLS AND FILLS

A. Place backfill and fill materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 698 and ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill material at 95 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill material at 88 percent.

3.14 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish Subgrades to required elevations within plus or minus 1 inch.

C. Grading Inside Grading Lines: Finish subgrade to a tolerance of ½ inch, when tested with a 10 foot straight-edge.

D. Contractor shall confirm that the proposed grades shown on the plans will not create a ponding water condition (i.e. an unintended low spot or pavement grades of less than 1%).

3.15 SUBSURFACE DRAINAGE

A. Drainage Piping: Drainage pipe is specified in Division 33 Section “Subdrainage” for foundation drainage and under-slab drainage systems.

B. Subsurface Drain: Place a layer of drainage fabric around perimeter of drainage trench. Place a 6 inch course of filter material on drainage fabric to support drainage pipe. Encase drainage
in a minimum of 12 inches of filter material and wrap in a drainage fabric, overlapping sides and ends at least 6 inches.

1. Compact each course of filter material to 95 percent of maximum dry unit weight according to ASTM D 698.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade. Overlay drainage backfill with one layer of drainage fabric, overlapping sides and ends at least 6 inches.

1. Compact each course of filter material to 95 percent of maximum dry density according to ASTM D 698.

3.16 SUBBASE AND BASE COURSES

A. If indicated on the plans or deemed necessary by the geotechnical engineer, install separation fabric on prepared subgrade according to manufacturer’s written instructions, overlapping sides and ends.

B. Under pavements and walks, place subbase course on separation fabric according to fabric manufacturer’s written instructions if fabric is called for on the plan or deemed necessary by the geotechnical engineer.

C. Under pavements and walks, place base on prepared subbase or subgrade as follows:
   1. Place base course material over subbase (or subgrade if subbase is not indicated).
   2. Compact subbase and base courses at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
   3. When thickness of compacted subbase or base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

D. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layers to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.17 DRAINAGE COURSE

A. Under slabs-on-grade, if indicated on the plans, place drainage fabric on prepared subgrade according to manufacturer’s written instructions, overlapping sides and ends.

B. Under slabs-on-grade, place drainage course on prepared subgrade and as follows:
   1. Compact drainage course to required cross sections and thickness to no less than 95 percent of maximum dry unit weight according to ASTM D 698.
   2. When compacted thickness of drainage course exceeds 6 inches, place materials in equal layers, with no more than 6 inches thick or less than 3 inches thick when compacted.

3.20 FIELD QUALITY CONTROL
A. Testing Agency: Construction Manager/Owner will engage a qualified independent Geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and to test any subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work. Comply with requirements.

C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate and remove and replace soil to depth required, recompact and retest until specified compaction is obtained.

3.21 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces becomes eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Protect all existing trees, bushes, plants, etc. indicated to remain during construction activities.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Unless otherwise indicated on the drawings, remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of it off the Owner’s property.
   1. Do not burn materials on the Owner’s property.

END OF SECTION 312000
SECTION 321216 - HOT-MIX ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   B. All paving materials and construction methods shall conform to the current standards and specifications of the Michigan Department of Transportation. Where these specifications are less stringent than the requirements of MDOT, the MDOT standards shall govern.

1.2 SUMMARY
   A. This Section includes installation of the following:
      1. Hot-mix asphalt concrete paving.
   B. Related Sections include the following:
      1. Division 32 1415 Section "Pavement Markings."
      2. Division 31 2000 Section "Earth Moving" for aggregate subbase and base courses.

1.3 DEFINITIONS
   A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.
   B. MDOT: Michigan Department of Transportation.

1.4 REQUIREMENTS
   A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of MDOT’S most current Standard Specifications for Construction. Where notes in this specification section differ from the MDOT standards, the MDOT standards shall govern.
   B. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F (4 degrees C), or surface is wet or frozen.
   C. Place bitumen mixture when temperature is not more than 15 F degrees (8 C degrees) below bitumen supplier’s bill of lading and not more than maximum specified temperature.

1.5 SUBMITTALS
   A. Submit aggregate and bituminous mix designs for review. Contractor shall confirm that the materials provided meet the required specifications, and provide material certification to the engineer. Material certification shall state that the products meet or exceed the requirements indicated on the plans and the requirements of the regulating authority.
B. Submittals and Resubmittals: Engineer will review each of Contractor's shop drawings and/or submittal data the initial time and, should resubmittal be required, one additional time to verify that reasons for resubmittal have been addressed by Contractor and corrections made. Resubmittal changes/revisions/corrections shall be circled. Engineer will review only circled items and will not be responsible for non-circled changes/revisions/corrections and additions. Should additional resubmittals be required, Contractor shall reimburse Owner for all costs incurred, including the cost of Engineer's services made necessary to review such additional resubmittals. Owner will in turn reimburse Engineer.

C. Requests for Information
   1. Engineer reserves the right to reject, any Request for Information (RFI) that the Engineer, at its sole discretion, deems frivolous.
   2. Engineer reserves the right to reject, any RFI that the Engineer, at its sole discretion, deems already answered in the Contract Documents.
   3. RFI process shall not be used for requesting substitutions. Procedures for substitutions are clearly specified elsewhere in the Contract Documents.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.
   1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.


1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:
   1. Prime and Tack Coats: Minimum surface temperature of 60 deg F.
   2. Slurry Coat: Comply with weather limitations of ASTM D 3910.
   3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
   4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Apply pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 50 deg F (10 deg C) for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Asphalt Cement: ASTM D 946.
B. Aggregate for Base Course: Conform with DOT standards.
C. Aggregate for Leveling Course: Conform with DOT standards.
D. Aggregate for Wearing Course: Conform with DOT standards.
E. Fine Aggregate: Conform with DOT standards.
F. Mineral Filler: Conform with DOT standards.
G. Tack Coat: Conform with DOT standards.
H. Asphalt Materials
   I. Asphalt Binder: Conform with DOT standards.
   J. Asphalt Cement: Conform with DOT standards.
   K. Prime Coat: Conform with DOT standards.
   L. Prime Coat: Conform with DOT standards.
   M. Tack Coat: Conform with DOT standards.

2.2 AUXILIARY MATERIALS
   A. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.
   B. Joint Sealant: ASTM D 3405 or AASHTO M 301, hot-applied, single-component, polymer-modified bituminous sealant.
   C. Pavement-Marking Paint: Refer to section 32 1415 “Pavement Marking”.
      1. Color: As indicated on Drawings or in accordance with MDOT.

2.3 ASPHALT MIX DESIGNS
   A. Hot-Mix Asphalt: Conform with DOT standards:

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify that compacted subgrade is dry and in suitable condition to support paving and imposed loads.
   B. Proof-roll subbase under observation by the testing agency. Use heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction. Proof-roll as indicated in “Earth Moving” section 31 2000.
   C. Verify that gradients and elevation of base are correct.
3.2 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
   1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch minimum or as indicated.
   1. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared compacted subgrade is ready to receive paving.

B. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure for 72 hours minimum.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

3.4 HOT-MIX ASPHALT CONCRETE PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
   2. Place hot-mix asphalt surface course in single lift.
   3. Spread mix at minimum temperature of 250 deg F.
   4. Install work in accordance with Michigan Department of Transportation (MDOT) standards.
   5. Compact pavement by rolling to density specified. Re-roll as necessary to achieve even and smooth finish without roller marks.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
   1. Clean contact surfaces and apply tack coat to joints.
   2. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
   1. Average Density: 96 percent of reference laboratory density according to AASHTO T 245, but not less than 94 percent nor greater than 100 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus 1/2 inch.
   2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
   1. Base Course: 1/4 inch.
   2. Surface Course: 1/8 inch.
   3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

C. Confirm minimum 1% slopes on asphalt pavement surfaces. Notify engineer prior to asphalt placement if minimum 1% slope is not met in any areas.

3.8 PAVEMENT MARKING
A. Refer to note 12 on the City of Detroit Standard Detail "HMA Surface on Concrete Base Utility Trench Construction Pavement Restoration" on sheet C2.4. Impacted pavement areas shall be restriped to match existing per City requirements.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.

2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
   
   a. One core sample will be taken for every 1000 sq. yd. (836 sq. m) or less of installed pavement, with no fewer than 3 cores taken.
   b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow excavated materials to accumulate on-site.

END OF SECTION 321316
SECTION 321313 - CEMENT CONCRETE PAVEMENTS, CURBS AND GUTTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. All paving materials and construction methods shall conform to the current standards and specifications of the Michigan Department of Transportation. Where these specifications are less stringent than the requirements of MDOT, the MDOT standards shall govern.

1.2 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:

1. Driveways and roadways.
2. Parking lots.
3. Curbs and gutters.
4. Sidewalks and platforms.
5. Wheel stops.

B. Related Sections include the following:

1. Division 31 1415 Section “Pavement Marking.”
2. Division 31 2000 Section “Earth Moving” for subgrade preparation, grading and subbase course.

1.3 PERFORMANCE REQUIREMENTS

A. Refer to MDOT’s current Standard Specifications for Construction.

1.4 SUBMITTALS

A. Submit aggregate and concrete mix designs for review. Contractor shall confirm that the materials provided meet the required specifications, and provide material certification to the engineer. Material certification shall state that the products meet or exceed the requirements indicated on the plans and the requirements of the regulating authority.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: An experienced installer with at least three (3) years in business who has completed pavement work similar in material, design, and extent to that indicated for this Project.

B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

1. Manufacturer must be certified according to the National Ready Mix Concrete Association’s Plant Certification Program.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer’s plant and each aggregate from one source.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Do not place concrete when base is wet or frozen. Protect concrete pavement from damage by rain or inclement weather.

C. Protect the concrete from freezing until it attains a compressive strength of at least 1,000 PSI. Do not place concrete pavement until the ambient air temperature away from artificial heat is at least 25 degrees Fahrenheit and rising. At the time of concrete placement, ensure a concrete temperature from 45 degrees Fahrenheit to 90 degrees Fahrenheit.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curved conditions.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated flat sheets, unfinished.

B. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed billet steel, unfinished.
C. Epoxy-Coated Reinforcement Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, deformed bars.

D. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

E. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.

F. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain steel bars.

G. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

H. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

I. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete.

J. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

2.3 CONCRETE MATERIALS

A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project. All material to meet current MDOT specifications.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry where indicated on Contract Documents.

B. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

C. White Membrane Curing Compound: ASTM C 309, Type 2.

2.5 RELATED MATERIALS


1. Thickness: ½ inch minimum and thicker where indicated.

B. Coloring Agent: Where indicated, ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
1. Color: n/a

C. Wheel Stops (use only if indicated on the plans): Precast, air-entrained concrete; 2500-psi minimum compressive strength; approximately 6 inches high, 9 inches wide, and 84 inches long. Provide chamfered corners and drainage slots on underside, and provide holes for dowel-anchoring to substrate.

1. Dowels: Galvanized steel, diameter of 3/4 inch, minimum length 18 inches.

D. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

E. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

F. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

2.6 CONCRETE MIXES

A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes.

B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.

C. Concrete mix design shall meet the requirements of MDOT Concrete Grade P1, with compressive strength, maximum water-cementitious materials ratio, slump limit, and air content per MDOT specifications. Maximum aggregate size in coarse aggregate gradation shall be 1.5 inches.

D. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.

E. Add air-entraining admixture at manufacturer’s prescribed rate to result in concrete at point of placement having an air content of 5.0 to 8.5 percent.

F. Use appropriate treatment per MDOT specifications where concrete will be placed under freezing conditions. Obtain approval of Engineer prior to placing concrete in freezing conditions. Concrete accelerators may be used in cold temperatures as noted below:

1. In concrete with steel reinforcement, a non-chloride accelerating admixture may be used. Admixture product shall be approved by MDOT per their current Qualified Products List (QPL) and the dosage shall be per manufacturer’s instructions. Admixtures containing calcium chloride shall not be used in concrete containing steel reinforcement.

2. In concrete without steel reinforcement, calcium chloride concrete accelerators may be used and shall meet the requirements of MDOT Specification Section 903.04.
G. Coloring Agent: Where indicated, add coloring agent to mix according to manufacturer’s written instructions.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94 and ASTM C 1116.

1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Comply with requirements and measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction and repair as required.

B. Verify that grades are correct.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations.

B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI’s "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.

B. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

C. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

D. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap to adjacent mats.

3.4 JOINTS
A. General: Construct construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

B. At all locations where new concrete abuts existing concrete, building wall, or supported slabs, place expansion joint and joint sealant.

C. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation joints.

1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

D. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where required.

1. Terminate joint filler 1 inch below finished surface to allow placement of joint sealant.

2. Joint sealant is required for all projects even if not indicated on the plans.

E. Expansion Joints: Place 1 inch (25 mm) wide expansion joints at maximum 40 foot intervals, if not indicated on drawings. Joints to be full depth of pavement. Place joint sealant at all expansion joints.

F. Install dowel bars and support assemblies at joints if indicated on the plans. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

G. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas. Construct ¼ inch wide contraction joints for a depth equal to at least one-third of the concrete thickness. Maximum spacing of contractions joints shall be 8’.

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 3/8-inch (10-mm) radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

H. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to the following radius.

1. Radius: 3/8 inch (10 mm).
3.5 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Do not add water to concrete during delivery, at Project site, or during placement.

D. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.

E. Cold-Weather Placement: Comply with ACI 306.1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

F. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R when hot-weather conditions exist.

3.6 CONCRETE FINISHING

A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.

B. Float Finish: Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots.

   1. Area Paving: Light broom, texture perpendicular to pavement direction.
   2. Curbs and Gutters: Light broom, texture parallel to pavement direction.
   3. Direction of Texturing: Parallel to pavement direction.
   4. Inclined Vehicular Ramps: Heavy broomed perpendicular to slope.
   5. Place sealer on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer’s instructions.

C. Provide detectable warning surface at all handicap ramps to meet ADA requirements in accordance with ANSI sections 406.13 and 705.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot-weather protection during curing.
B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer’s written instructions.

C. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer’s written instructions.

3.8 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation Variation: 1/4 inch.


3. Surface Variation: Gap below 10-foot- long, unleveled straightedge not to exceed 1/4 inch.

4. Maximum cross slope for walks, ramps, platforms: 2%

5. Maximum longitudinal walk slopes not requiring landings and handrails: 5%

6. Maximum longitudinal ramp slopes: 8.33% (1 on 12 slope)

3.9 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.

B. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer’s recommended rates to provide a minimum wet film thickness of 15 mils.
1. If indicated on the plans, spread glass beads uniformly into wet pavement markings at a rate of 6 lb/gal.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified.

B. Testing Services: Testing shall be performed according to the following requirements:

1. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.

2. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.

C. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

D. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements as directed by the Engineer.

B. Remove and replace concrete sidewalks and/or ramps that do not comply with maximum slopes indicated in Section 3.8A above.

C. Protect concrete from damage. Exclude traffic from pavement for at least fourteen (14) calendar days after placement.

END OF SECTION 321313
SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All paving materials and construction methods shall conform to the current standards and specifications of the Michigan Department of Transportation. Where these specifications are less stringent than the requirements of MDOT, the MDOT standards shall govern.

1.2 SUMMARY

A. General – all expansion joints are to receive joint sealant. Contraction and other joints receive sealant only if indicated on the plan.

B. This Section includes the following:

1. Expansion and contraction joints within cement concrete pavement.
2. Joints between cement concrete and asphalt pavement.

C. Related Sections include the following:

1. Division 32 Section "Hot-Mix Asphalt Concrete Paving" for constructing joints between concrete and asphalt pavement.
2. Division 32 Section "Cement Concrete Pavements, Curbs and Gutters" for constructing joints in concrete pavement.

1.3 SUBMITTALS

A. Product Data, shop drawing submittals are not required. Contractor shall confirm that the materials provided meet the required specifications, and provide material certification to the engineer. Material certification shall state that the products meet or exceed the requirements indicated on the plans and the requirements of the regulating authority. Shop drawings will not be reviewed.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
B. Store and handle materials to comply with manufacturer’s written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
2. When joint substrates are wet or covered with frost.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Use products meeting MDOT’s current specifications.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: Gray.

2.3 COLD-APPLIED JOINT SEALANTS

A. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.

1. Products:
   a. Crafco Inc.; RoadSaver Silicone.
   b. Dow Corning Corporation; 888.
   c. Approved equal.

B. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.

1. Products:
   a. Crafco Inc.; RoadSaver Silicone SL.
   b. Dow Corning Corporation; 890-SL.
c. Approved equal.

2.4 HOT-APPLIED JOINT SEALANTS

A. Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D 3406.
   1. Products:
      c. Approved equal.

B. Sealant for Concrete and Asphalt: Single-component formulation complying with ASTM D 3405.
   1. Products:
      a. Koch Materials Company; Product No. 9005.
      b. Koch Materials Company; Product No. 9030.
      d. Approved equal.

2.5 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.6 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of backer materials.
2. Do not stretch, twist, puncture, or tear backer materials.
3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses provided for each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.

G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 321373
SECTION 323119
DECORATIVE METAL FENCES AND GATES

PART 1 GENERAL

1.1 SUMMARY
   A. Section Includes: Aluminum louver fences (FNC-1) and manually-operated swing gates (FNC-2).

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.
   C. Samples: 18 inches square, including louver infill, with specified finish.

1.3 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For gate operators to include in maintenance manuals.

1.4 QUALITY ASSURANCE
   A. Installer Qualifications: Fabricator of products.
   B. Welding Qualifications: Qualify procedures and personnel according to the following:
      1. AWS D1.1/D1.1M, "Structural Welding Code - Steel"
      2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
      1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 PRODUCTS

1.5 ALUMINUM LOUVER FENCES
   A. General: Provide decorative aluminum fencing system consisting of vertical, fixed louver, modular fence panels fabricated with extruded aluminum framing bars and supported by extruded aluminum fence posts.
   B. Inclined, flanged louver blade providing 80 percent visual blocking.
      2. Fence Panel:
         a. Fixed louver bars: Extruded aluminum louver bars, 1-31/32 inches wide, spaced at 2-1/16 inches. Extend louver flange to allow 80 percent direct visual screening.
         b. Cross bars: 1/2 by 1/8 inch flat bars welded perpendicular to back side of louver bars and spaced at 18 inches
      3. Posts: 3-inch square extruded tubular aluminum sections with solid aluminum caps.
   C. Inclined, flanged louver blade providing 100 percent visual blocking.
      2. Fence Panel:
a. Fixed louver bars: Extruded aluminum louver bars, 1-31/32 inches wide, spaced at 1-13/16 inches. Extend louver flange to allow 100 percent direct visual screening.
b. Cross bars: 1/2 by 1/8 inch flat bars welded perpendicular to back side of louver bars and spaced at 18 inches.
3. Posts: 3-inch square extruded tubular aluminum sections with solid aluminum caps.

D. V-shaped louver blade providing 100 percent visual blocking.
   2. Fence Panel:
      a. Fixed louver bars: V-shaped extruded aluminum louver bars, 1-3/4 inches wide by 2-1/2 inches high, spaced at 2-5/8 inches and providing 100 percent direct visual screening.
      b. Framing bars: Extruded aluminum flat bars welded to ends of louvers.
   3. Posts: 3-inch square extruded tubular aluminum sections with solid aluminum caps.

E. Extruded tubular aluminum blades providing with either 80 or 100 percent visual blocking.
   2. Fence Panel: Height and width of panels as shown.
      a. Fixed louver blades: Extruded tubular aluminum louver blades, inclined at 45 degrees, and spaced at 2.83 inches and to provide 100 percent direct visual screening. [spaced at 3.4 inches to provide 80 percent direct visual screening.]
         1) Size: 1/2 by 4 inches.
         2) Material thickness: 0.09 inch.
      b. Framing bars: Extruded aluminum flat bars welded to ends of louvers.
   3. Posts: 3-inch square extruded tubular aluminum sections with solid aluminum caps.

2.1 SWING GATES

A. Aluminum Frames and Bracing: Fabricate members from square extruded-aluminum tubes [1-1/2 by 1-1/2 inches] [2 by 2 inches] [2-1/2 by 2-1/2 inches] <Insert size> with [0.100-inch] [0.125-inch] [0.140-inch] [0.154-inch] wall thickness.

B. Frame Corner Construction: Welded and 5/16-inch diameter, adjustable truss rods for panels 5 feet wide or wider.

C. Additional Rails: Provide as indicated, complying with requirements for fence rails.

D. Infill: Comply with requirements for adjacent fence.

E. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide [center gate stops] [and] [cane bolts] for pairs of gates. [Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.]
   1. <Insert requirements for padlocks and chains if not Owner furnished>.

F. Spring Hinges: BHMA A156.17, Grade 1, suitable for exterior use.
   1. Function: [320 - Gate spring pivot hinge. Adjustable tension] [321 - Gate spring pivot hinge. Fixed tension].

G. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.
   2. Material: Wrought steel, forged steel, cast steel, or malleable iron.

H. Rim Locks: BHMA A156.5, Grade 1, suitable for exterior use.
1. **Function:** [621 - Latchbolt by key from outside and by turn from inside. Latchbolt is held retracted by device from inside] [622 - Deadbolt by key from outside and by turn from inside] [629 - Deadlocking latchbolt by key from outside and by turn from inside] [626 - Interlocking deadbolt operated by key from either side] [627 - Interlocking deadbolt operated by key from outside and by turn from inside]

2. **Material:** Cast, forged, or extruded brass or bronze.

3. **Mounting Plate:** Configuration necessary for mounting locks. Fabricate from 1/8-inch-thick, [steel] [aluminum] plate.

**I. Mortise Locks:** BHMA A156.13, Grade 1, suitable for exterior use.

1. **Function:** [F06 - Holdback lock] [F07 - Storeroom or closet lock] [F09 - Apartment, exit, or public toilet lock] [F16 - Double-cylinder dead lock] [F17 - Dead lock] <Insert function>.

2. **Material:** Brass or bronze.

3. **Levers:** Cast, forged, or extruded brass or bronze.

4. **Mounting Box:** Configuration necessary to enclose locks. Fabricate from 1/8-inch-thick, [steel] [aluminum] plate.

**J. Cane Bolts:** Provide for inactive leaf of pairs of gates. Fabricated from [1/2-inch-] [3/4-inch-] diameter, round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in [closed position] [both open and closed positions].

**K. Aluminum Finish:** Baked enamel or powder coating.

### 2.2 ALUMINUM

**A. Aluminum, General:** Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.

**B. Extrusions:** ASTM B 221, Alloy 6063-T5.

**C. Tubing:** ASTM B 429, Alloy 6063-T6.

**D. Plate and Sheet:** ASTM B 209, Alloy 6061-T6.

**E. Die and Hand Forgings:** ASTM B 247, Alloy 6061-T6.

**F. Castings:** ASTM B 26/B 26M, Alloy A356.0-T6.

### 2.3 FINISH

**A. Baked-Enamel or Powder-Coat Finish for Aluminum:** AAMA 2603 except with a minimum dry film thickness of 2 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. **Color and Gloss:** Custom Color as selected by Architect.

**B. Polyester powder coating:** Electrostatically applied colored polyester powder coating heat cured to chemically bond finish to metal substrate.

1. **Minimum hardness measured in accordance with ASTM D3363:** 2H.

2. **Direct impact resistance tested in accordance with ASTM D2794:** Withstand 160 inch-pounds.

3. **Salt spray resistance tested in accordance with ASTM B117:** No undercutting, rusting, or blistering after 500 hours in 5 percent salt spray at 95 degrees F and 95 percent relative humidity and after 1000 hours less than 3/16 inch undercutting.

4. **Weatherability tested in accordance with ASTM D822:** No film failure and 88 percent gloss retention after 1 year exposure in South Florida with test panels tilted at 45 degrees.
2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
   1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Division 03 Section “Cast-in-Place Concrete” with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C 387 mixed with potable water according to manufacturer’s written instructions.

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and specifically recommended by manufacturer for exterior applications.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Install fences by setting posts as indicated and fastening rails and infill panels to posts.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
   1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
   2. Concrete Fill: vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
   3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
   4. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least 3/4 inch larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.
      a. Extend posts at least 5 inches into sleeve.
      b. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer’s written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.
   5. Posts Set into Voids in Concrete: Form or core drill holes not less than 3/4 inch larger than outside diagonal dimension of post.
      a. Extend posts at least 5 inches into concrete.
      b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.
3.3 **GATE INSTALLATION**

A. Install gates according to manufacturer’s written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.4 **INSTALLED WORK**

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

**END OF SECTION**
SECTION 32 31 19
METAL FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Maintenance Area Fencing.
   2. Maintenance Area Gates.

1.2 REFERENCES

A. ASTM-A82: Cold Drawn steel wire , Plain, for Concrete Reinforcement.
B. ASTM-A185: Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
C. ASTM-A1008 Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy (HSLA) and HSLA with Improved Formability
E. ASTM-A513-00: Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
F. ASTM-A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

S. ASTM-F2919: Standard Specification for Welded Wire Mesh Fence Fabric (Metallic-Coated or Polymer Coated) with Variable Mesh Patterns or Meshees Greater than 6 sq. in. [3871 mm2] in Panels

T. ASTM-F626: Standard Specification for Fence Fittings

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: Material descriptions, construction details, dimension of individual components and profiles, and finishes for:
   1. Fence and gate posts, rails, and fittings.
   2. Gates and hardware.

B. Shop Drawings: locations of fence, each gate, posts, rails, and details of gate swing, or other operation, hardware, and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans, elevations, sections, gate swing and other required installation and operational clearances, and details of post anchorage, attachment and bracing. Installation procedures and instructions by manufacturer describing all details for a typical fence and gate.

C. Samples: For each fence material and for each color specified.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Product test reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced insta ller who has completed fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations: Obtain each color, grade, finish, type, and variety of components for fences and gates from one source with resources to provide fences and gates of consistent quality in appearance and physical properties.

1.8 PROJECT CONDITIONS

A. Field Measurements: verify layout information for fences and gates shown on drawings in relation to property survey and proposed and existing structures. Verify dimensions by field measurements.
PART 2 - PRODUCTS

2.1 MECHANICAL AREA FENCING

A. Manufacturer: Omega II [https://www.omegafence.com] or approved equal.

B. Fences
   1. Product: Omega Architectural
   2. Panel Widths: As indicated in Drawings
   3. Height: As indicated in Drawings, utilizing multiple stacked panels

C. Gates
   1. Product: Omega Architectural
   2. Width: Standard 8’ swing gate (two 4-foot leafs)
   3. Hardware: Manufacturer-provided lock (LAKQ U2)

D. Posts
   1. 3” square posts, embedded

E. Color: Custom RAL code per Architect

F. Accessories: All manufacturer-provided posts, brackets, hardware and accessories as required per drawings and manufacturer’s installation details.

G. Manufacturer’s Materials:
   1. The wire mesh fence panel is welded by resistance using 6 gauge - 0.192 pre-galvanized steel wire, welded at each crossing to form rectangles of 2 in. x 6 in. The cold rolled wire shall have a tensile strength of at least 75,000 psi and a 2 172 lbs break strength as per ASTM A185 & A853. One end of the vertical wires of the panel shall exceed 1” (25 mm) from the last or the first horizontal wire thereby creating a spiked top or bottom depending of its position when installed. The other end is cut flush. Panels shall have a number of folds according to the table 2 below depending on the respective height of the panel. Note: Panel camber may not exceed 0.094” (2.5 mm).
   2. Fence and gate posts are cold rolled from 1008 grade steel and meet ASTM 500 and ASTM A787-01. Fence posts are to be minimum 11 gauge, as recommended by the manufacturer based on post height.
   3. Post bracket kits include 16 gauge steel collar and wire retaining plate, nut, washer and carriage bold, all galvanized steel.
   4. Post caps are made out of an aluminum alloy.
   5. Gate frames shall be made in accordance with ASTM F900 (1984) using galvanized square steel tube 16 ga, welded.
   6. Gate hardware conforms with ASTM F900 (1984) for hinges, latch, drop rods, and shall be hot-dip galvanized steel, and sized to assure proper gate operation. Non moving parts shall be powder-coated.

H. Manufacturer’s Coatings:
   1. The wire meshes is coated with 0.5 oz./sq.ft. (150 g/m2) zinc in conformity with ASTM A 641 (1989) Class 1
   2. The fence posts, the swing gate frame and the posts are zinc coated (galvalum process) with a minimum of 0.9 oz/sq.ft.(275 g/m2) as per ASTM A653 G90.
   3. Polyester coating to be minimum 4 mils applied by an electrostatic method. Coating shall cover all surfaces of the wire and post sections. Coating shall be capable of withstanding the following tests:
      a. Mechanical adhesion test as per ASTMD 3359 (1990) - Method B.
c. Salt spray testing with a min. of 1,000 hrs without red rust appearance, as per ASTM B 117 (1990).
e. Exposure to ultraviolet light with exposure of 1000 hours using apparatus Type E and 63°C as per ASTM D1499

2.2 MISCELLANEOUS MATERIALS

A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi (20 MPa), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C 387/C 387M mixed with potable water according to manufacturer's written instructions.

B. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

2.3 FABRICATION

A. Posts and fence panels shall be pre-cut to specified lengths by manufacturer. No field cutting is permitted.

B. The manufactured panels and posts shall be subjected to an inline electrode position coating (E-Coat) process consisting of a multi-stage pretreatment/wash (with zinc phosphate), followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils (0.058 mm).

C. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for Commercial weight fences under ASTM F2408.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance.

B. Do not begin installation before final grading is completed, unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacing indicated in firm, undisturbed or compacted soil.

B. Post Setting: Set posts in concrete footing.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting. Use of mechanical devices to set posts is not permitted.
2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

3. Concealed Concrete Footings: Stop footings below grade as indicated on Drawings to allow covering with surface material.

C. Install fence panels and brackets according to manufacturer's written instructions.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

END OF SECTION 32 31 19
SECTION 32 33 00
SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Bike Racks.
   2. Pedestrian Bollards.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS
A. Maintenance data.

PART 2 - PRODUCTS

2.1 BIKE RACKS
A. Manufacturer: Landscape Forms Inc., (800) 521-2546, www.landscapeforms.com
B. Product: Bola Bike Rack
C. Finish: Stainless Steel
D. Mounting: Embedded

2.2 PEDESTRIAN BOLLARDS
B. Product: 8-2C2 Bollard
C. Finish: Polyester Powdercoat,
D. Color: “Cast Iron Grey”
E. Mounting: Embedded

PART 3 - EXECUTION

3.1 INSTALLATION
A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

END OF SECTION 32 33 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Sleeving.
3. Wire and wire connectors.
5. Sprinklers.
6. Isolation valves.
7. Automatic control valves.
8. Quick couplers.

1.3 DESCRIPTION OF WORK

A. Extent of irrigation system work is shown on the drawings and by provisions of this Section.

B. The scope of work includes connecting to two different watersources for the irrigation systems at MacKenzie House and Hillberry Theater.

C. The sprinkler systems shall be constructed using the isolation valves, sprinklers, quick coupling valves, piping, fittings, controllers, wiring, etc. of sizes and types as shown on the drawings and as called for in these specifications. The system shall be constructed to grades and conform to areas and locations as shown on the drawings.

D. Piping and valve locations shown on the drawings are essentially diagrammatic. Spacing of the valves and sprinklers are shown on the drawings and shall be exceeded only with the permission of the Owner's Representative.

E. Unless otherwise specified or indicated on the drawings, the construction of the sprinkler system shall include the furnishing, installing and testing of all mains, laterals, fittings, sprinklers, quick coupling valves, automatic control valves, controllers, electric wire, backflow preventer, master valve/flow sensor, rain sensor, valve boxes, isolation valves, and other necessary specialties and the removal and/or restoration of existing improvements, excavation and backfill, and all other work in accordance with plans and specifications as required for a complete system.
1.4 PERFORMANCE REQUIREMENTS

A. Irrigation zone control shall be automatic operation with controller and automatic control valves.

B. Location of irrigation valves, piping, and other system components: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of landscape areas indicated.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Submit product information on sprinklers, nozzles, bubblers, plastic isolation valves (upstream of zone valves), quick coupling valves and stabilizers, schedule 80 three elbow swing joint with O-Ring seals, 14 AWG two-wire cable, 14 AWG single strand wire, decoders, surge arrestors, moisture sensors, rain sensors, wire connectors, valve boxes, PVC pipe and fittings, pipe primer and glue, polyethylene lateral pipe and fittings, stainless steel pipe clamps master valve and flow meter, and control timers. Include manufacturer granted Contractor Training Certification Certificate for the controller to be used.

C. Operation and Maintenance Data: Submit operation and maintenance manuals for sprinklers, controllers, automatic control valves, and quick coupling valves.

1.6 QUALITY ASSURANCE

A. The Contractor shall maintain continuously a competent superintendent, satisfactory to the Owner, with authority to act for him in all matters pertaining to the work.

B. The Contractor shall coordinate his work with the other trades.

C. The Contractor shall confine his operations to the areas to be improved and to the areas allotted him by the Owner's representative for material and equipment storage.

D. The Contractor shall have a minimum of five years experience installing irrigation systems of comparable size and complexity.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver plastic piping in bundles, packaged to provide adequate protection of pipe ends, both threaded or plain.

B. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

C. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

D. Deliver irrigation system components in manufacturer's original undamaged and unopened containers with labels intact and legible.
E. Store and handle materials to prevent damage and deterioration.

F. Provide secure and locked storage for all brass, copper, bronze and stainless-steel items including all valves, pipe fittings, wire, pipe, sprinklers and similar components that cannot be immediately replaced, to prevent installation delays.

1.8 PROJECT CONDITIONS

A. The bidder acknowledges that he has examined the site, plans and specifications, and the submission of a proposal shall be considered evidence that examination has been made.

B. It shall be the contracting installer's responsibility to report to the Owner's authorized representative any deviations between drawings, specifications and the site. Failure to do so prior to the installing of equipment and resulting in replacing and/or relocation of equipment shall be done at the Contractor's expense.

C. The exact location of existing utilities and structures and underground utilities are not indicated on the drawings; their locations shall be determined by the Contractor, and he shall conduct his work so as to prevent interruption of service or damage to them. The Contractor shall protect existing structures and utility services and be responsible for their replacement if damaged by him.

D. Minor adjustments in system layout will be permitted to clear existing fixed obstructions. Final system layout shall be acceptable to Owner's Representative.

E. Do not willfully install the sprinkler system as shown on the drawings when it is obvious in the field that unknown obstructions, grade differences or differences in the area dimensions exist that might not have been considered in the engineering. Such obstructions or differences should immediately be brought to the attention of the owner's authorized representative. In the event this notification is not performed, the irrigation contractor shall assume full responsibility for any revisions necessary.

F. Landscaping shall supersede irrigation locations wherever there is a conflict between the two.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Quick coupling valve keys and hose swivels: Provide owner with two (2) valve keys and hose swivels for use with quick coupling valve models installed as part of this work.

1.10 SERVICE AND MAINTENANCE

A. The Contractor shall service both systems at the Owner's request during the guarantee period and shall be paid for work performed which is not covered by the guarantee.

B. Contractor shall winterize the both systems the first year as part of this contract and will provide written instructions to the Owner for future service and maintenance.
C. Return to the site during the subsequent spring season and demonstrate to the Owner the proper procedures for the system start-up, operation and maintenance.

D. After completion, testing and acceptance of the system, the Contractor will instruct the Owner's personnel in the operation and maintenance of both systems.

1.11 OWNER’S ACCEPTANCE

A. The completion of the contract will be accepted and Notice of Completion recorded only when the entire contract is completed to the satisfaction of the Owner’s authorized representative.

B. Within ten (10) days of the Contractor’s notification that the installation is complete, the Owner, or his Representative, will inspect the installation and if a final acceptance is not given, will prepare a "Punch List" which, upon completion by the Contractor, will signify acceptance by the Owner.

C. Provide AutoCad plan with dimensions from two fixed points for mainline and wire routings, all valves, watersource and controller location per the Owner requirements.

D. Provide a reproducible, 30” x 42” irrigation system record drawing and flashdrive with Autocad drawing of GPS information listed in Section C., above, along with drawing saved as a pdf.

   1. Legibly mark drawings to record actual construction.

   2. Locate horizontal locations, with a minimum of two dimensions to permanent surface improvements, for each automatic valve, isolation valve, all wire splice boxes, extra wire locations and quick coupling valves.

   3. Identify field changes with dimensions and details as required as well as changes made by Change Order.

E. Provide a zone identification drawing indicating with color, the different zones. Include table on drawing with zone description. Drawing shall be 11” x 17” laminated.

F. Final payment will not be made without the receipt of accurate as-built drawings and zone identification drawings by The Owner’s Representative.

G. Provide four hours to assist landscape contractor in setting zone operation times for all zones on both controllers. Irrigation system will not be considered complete until control system is in complete working order.

1.12 WARRANTY

A. It shall be the Contractor's responsibility to ensure and guarantee satisfactory operation of both systems and the workmanship and restoration of the area. The both systems shall be guaranteed to be complete and perfect in every detail for a period of one year from the date of its acceptance and he thereby agrees to repair or replace any such defects occurring within that year, free of expense to the Owner. Minor maintenance and adjustment shall be by the Owner.
B. Contractor is to guarantee that all trenches and other disturbed areas be free from heaving or settling more than one-quarter inch (1/4”). Should it become necessary to adjust the grade, regrade the trench and reseed. This no settlement clause shall extend over the entire period of guarantee of the job.

C. One month prior to the conclusion of the warranty period, the Contractor and landscape contractor shall meet at the site and adjust the zone watering times on the controllers to reflect run times for established plant material.

PART 2 - PRODUCTS

2.1 GENERAL

A. All material to be incorporated in this system shall be new and without flaws or defect and quality and performance as specified. All material overages at the completion of the installation are the property of the Contractor and are to be removed from site.

B. The Contractor shall use materials as specified. Material other that specified will be permitted only after written application by the Contractor and written approval by the Owner's Representative. Substitutions will only be allowed when in the best interest of the Owner.

2.2 PIPE, SLEEVEING, AND FITTINGS (2.5" and smaller and all sleeving)

A. Pipe sizes shall conform to those shown on the drawings. No substitutions of smaller pipe sizes will be permitted, but substitutions of larger size may be approved. All pipe damaged or rejected because of defects shall be removed from the site at the time of said rejection.

B. Provide pipe continuously and permanently marked with manufacturer's name or trademark, size, schedule and type of pipe, working pressure at seventy-three (73) degrees Fahrenheit and National Sanitation Foundation (NSF) approval.

C. All PVC piping, 2” size, and all sleeves, shall be ASTM D2241, rigid, unplasticized Polyvinyl chloride, extruded from virgin parent material. Provide pipe homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, wrinkles, and dents.

D. All pipe, and all sleeves shall be SDR 21, 200 PSI, PVC unless specifically noted on the drawings.

E. Sleeves shall be solvent weld PVC pipe.

F. PVC pipe shall be solvent weld type.

G. PVC pipe fittings for sizes two and one half inch (2.5") and smaller shall be ASTM D2466 schedule 40 PVC molded fittings suitable for solvent weld, except all threaded PVC pipe fittings as noted on the drawings shall be ASTM D2467, schedule 80 PVC.

H. PVC pipe fittings shall be schedule 40 PVC, solvent weld.

I. Primer and solvent for use with PVC pipe to conform to ASTM D2564. Primer to be purple in color. Solvent to be appropriate for pipe and fitting type and weather conditions.
J. Polyethylene Pipe with Controlled ID: ASTM F 771, PE 3408 compound; SIDR 15.
   1. Insert Fittings for PE Pipe: ASTM D 2609, nylon or propylene plastic with barbed ends. Include stainless steel worm gear clamps with stainless steel screw.

K. All copper pipe shall be type "L" hard copper. Fittings shall be cast brass or wrought copper.

L. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

M. Dielectric Unions: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature. End Connections to be solder-joint copper alloy and threaded ferrous.

N. PE Pipe with Controlled ID: ASTM F 771, PE 3408 compound; SIDR 11.5.

O. Insert Fittings for PE Pipe: ASTM D 2609, nylon or propylene plastic with barbed ends. Include stainless steel worm gear clamps.

P. Ductile-Iron Pipe with Mechanical Joints: AWWA C151, with mechanical-joint bell and spigot ends.
   1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.3 WIRE AND WIRE CONNECTORS (HILLBERRY SYSTEM)

A. All two-wire cable shall be Type UL approved, for direct burial.

B. Control system shall be either Baseline, Hunter, Rainbird. Cable, decoders, surge arrestors and sensors shall be those manufactured by Baseline, Hunter, Rainbird.

C. Two wire cable shall be size AWG fourteen (14) and be manufactured for use with Baseline, Hunter, or Rainbird control systems.

D. Decoders shall be those manufactured for use with Baseline, Hunter, or Rainbird control systems.

E. All control cable shall be run next to the mainline pipe. Where wire cannot be installed next to mainline pipe, install wire inside 1" conduit.

F. Low voltage wire connectors to be made using wire nuts and 3M DBYR connectors. Refer to Baseline, Hunter, or Rainbird requirements.

G. One hundred and twenty volt (120 v) or heavier splices made underground are to be made using wire nuts and 3M brand Scotch-Lok.
2.4 WIRE AND WIRE CONNECTORS (MACKENZIE HOUSE SYSTEM)

A. All wire shall be single strand Type UL approved, for direct burial.

B. Control system shall be either Hunter, Rainbird, or Toro.

C. Wire shall be size AWG fourteen (14) for use with irrigation systems and direct burial installations.

D. All wire shall be run next to the mainline pipe. Where wire cannot be installed next to mainline pipe, install wire inside 1” conduit.

E. Low voltage wire connectors to be made using wire nuts and 3M DBYR connectors.

F. One hundred and twenty volt (120 v) or heavier splices made underground are to be made using wire nuts and 3M brand Scotch-Lok.

2.5 SPRINKLERS

A. Install fittings and sprinkler heads in accordance with manufacturer's instructions, except as otherwise indicated.

B. Set sprinkler heads perpendicular to finished grades, except as otherwise indicated, and positions to prevent contact with grounds maintenance equipment. Locate sprinkler heads to assure proper coverage of indicated areas. Do not exceed sprinkler head spacing distances indicated.

C. Provide pop-up spray heads with a two elbow swing joint riser as shown on Drawings.

D. Refer to legend on irrigation sheet for models and manufacturers.

2.6 CONTROL SYSTEM

A. Hillberry system: Control timer is to be a Baseline, Hunter, Rainbird two-wire system. Refer to notes and details on irrigation detail sheet and legend.

B. MacKenzie system: Control timer is to be a Hunter, Rainbird, or Toro conventionally wired controller system.

2.7 AUTOMATIC CONTROL VALVES

A. Automatic valves shall be globe-type diaphragm valves of normally closed design, self-cleaning, with plastic bodies and covers and manual flow control. Operation shall be controlled by a slow-closing integrally mounted heavy-duty 24-volt AC solenoid complying with National Electrical Code, Class II Circuit; solenoid coil shall be completely waterproof, potted in epoxy resin within a plastic-coated stainless-steel housing.

B. Refer to details on irrigation detail sheet.

C. Plastic ball valves shall be installed upstream of automatic valves. Size shall equal automatic valve size.
D. Install automatic valves inside 11” x 19” rectangular valve boxes, one valve per box.

2.8 QUICK COUPLING VALVE

A. Quick coupling valves shall have cast brass bodies with spring-loaded, self-closing thermoplastic locking covers and 1-inch IPS inlet.

B. Quick coupling valve model to be as noted in the irrigation legend and include schedule 80 three elbow swing joint with O-ring seals, stabilizer and concrete support.

C. Refer to detail on irrigation detail sheet.

2.9 VALVE BOXES

A. Valve Access Boxes to be tapered enclosure of rigid plastic material comprised of fibrous components chemically inert and unaffected by moisture, corrosion, and temperature changes.

B. Boxes to be size as noted in the details on the detail sheet. Side walls to extend at least two inches (2") below the bottom of the valve body; use extensions as necessary.

C. Accessories:
   1. Drainage fill to be 3/4” crushed stone.
   2. Fill shall be clean soil, free of stones larger than two inches (2") in diameter, foreign matter, organic material and debris.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine final grades and installation conditions. Do not start irrigation system work until unsatisfactory conditions are corrected.

B. All city and state laws, rules and regulation governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications and their provisions shall be carried out by the contractor

C. It is the responsibility of the irrigation contractor to familiarize himself with all grade differences, location of walls, retaining walls, structures and utilities. The irrigation contractor shall repair or replace all items damaged by his work at no expense to the owner. He shall coordinate his work with other contractors for the location and installation of pipe sleeves and lateral lines through walls, under roadways, drives, and paving, etc.

D. The contractor shall obtain the pertinent engineering, landscape, or architectural plans before beginning work.

E. The contractor shall obtain all necessary permits required to perform the work indicated herein before beginning work.
F. Do not willfully install the sprinkler system as shown on the drawings when it is obvious in the field that unknown obstructions, grade differences or differences in the area dimensions exist that might not have been considered in the engineering. Such obstructions or differences should immediately be brought to the attention of the owner's authorized representative. In the event this notification is not performed, the irrigation contractor shall assume full responsibility for any revisions necessary.

G. Tree locations take priority over irrigation piping. Stake tree locations prior to trenching for pipe. Obtain approval from owner's representative for all pipe routing and valve box locations prior to initiating any work.

3.2 PREPARATION

A. Locations of the irrigation components need to be staked and approved prior to initiating any work. Consult with all trades and individuals to gain approval of positioning of the irrigation components including Owner's Representative, landscape architect, controller representative, and engineers to ensure that all components are placed in locations where they will operate most efficiently and not be in the way of utilities, plant material and other site components. Any items which are installed and later found to need re-installation because approval was not granted by the knowledgeable party, will be done at the irrigation contractor's expense.

B. Set stakes to identify locations of proposed piping and valve boxes. Obtain Owner's Representatives approval before excavation.

C. Obtain latest manufacturer's recommended installation requirements for components. Any deviation between these specifications and plans and those recommendations are to be brought to the attention of the Owner's Representative.

3.3 EXCAVATION AND BACKFILLING

A. Excavating shall be considered unclassified and shall include all materials encountered, except materials that cannot be excavated by normal mechanical means. Excavate trenches of sufficient depth and width to permit proper handling and installation of pipe and fittings. Excavate to depths required to provide two-inch (2") depth of earth fill or sand bedding for piping when rock or other unsuitable bearing material is encountered.

B. Fill to match adjacent grade elevation with approved earth fill material. Place and compact fill in layers not greater than eight-inch (8") depth.

C. Provide approved fine-grained earth fill or sand to a point four inches (4") above the top of pipe, as detailed on the irrigation detail sheet.

D. Fill to within six inches (6") of final grade with approved excavated or borrow fill materials free of lumps or rocks larger than 2" in any dimension.

E. The top six inches (6") of backfill shall be topsoil, free of rocks, subsoil or trash. Any special soil mixture shall be replaced to the original condition it was prior to irrigation installation.

F. Mechanically compact backfill in 6-inch lifts to a minimum of 95 percent (maximum density) under pavement and 90 percent in unpaved areas.
G. Compacted backfill shall match surrounding grades. Repair of trench settlement and affected landscape shall be at Contractor's expense.

H. All mainline pipe is to be installed using open trenches. Lateral pipe may be installed using vibratory plow if suitable soil conditions exist.

I. All trenches opened during any particular working day are to be backfilled the same day. Open or partially backfilled trenches left overnight or unsupervised shall be barricaded.

J. Mechanically compact backfill in 6-inch lifts to a minimum of 95 percent (maximum density) under pavement and 90 percent in unpaved areas.

K. Compacted backfill shall match surrounding grades. Repair of trench settlement and affected landscape shall be at the irrigation contractor's expense.

3.4 PIPING INSTALLATION

A. Install plastic pipe in accordance with manufacturer's installation instructions and ASTM D2274, particularly as it applies to thermal expansion and contraction.

B. Store pipe such that it is protected from oil and grease and from prolonged exposure to sunlight and excessive heat.

C. Solvent welding shall be in strict accordance with manufacturer's recommendations and ASTM Standards D2564 and D2855, especially as they apply to ambient temperature.

D. Maintain interior free of dirt and debris. Close open ends of pipe by capping, taping or other acceptable method when pipe installation is not in progress, including overnight, to prevent entrance of foreign matter.

E. Pipe and fittings shall be handled in a manner to ensure delivery to the trench in sound, undamaged condition. If the coating of any pipe or fitting is damaged or if materials are in poor condition, it shall be repaired or replaced.

F. Allow glued joints to set at least twenty-four hours before pressure is applied to the system.

G. All mainline and contiguously pressurized pipe is to be installed using open trench and backfill.

H. Minimum depth of cover over lateral pipe shall be twelve inches (12") and over mainline pipe shall be eighteen to twenty-four inches (18"-24").

I. Install piping in sleeves under parking lots, roadways, and sidewalks prior to paving. Minimum depth to be 18"-24" beneath subgrade.

J. Where sleeves need to be installed beneath paving, coordinate work with paving contractor to set sleeves prior to the paving process.

K. Where more than one sleeve is to pass beneath paving, install sleeves 6" apart, as measured from the outside wall of the sleeves, in an even lateral layout. Do not install sleeves stacked on top of each other or rubbing against each other.

L. Install sleeves made of SDR 21, 200 PSI, PVC pipe and socket fittings, and solvent-cemented joints.
3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Copper-Tubing Soldered Joints: Apply ASTM B 813 water-flushable flux to tube end unless otherwise indicated. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.

E. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

3.6 VALVE INSTALLATION

A. Electric valve installation shall be as indicated on the drawings. All electrical, quick coupler, and manual valves shall be enclosed in a valve box. Add valve box manufactured extensions as required to prevent soil settlement around the valve. Set box flush with finish grade and aligned with adjacent boxes and/or adjoining sitework.

B. Install valve access boxes on a suitable base of gravel to provide a level foundation at proper grade and to provide drainage of the access box.

C. Support box with bricks to protect pipe under box and box settlement. For rectangular boxes, support with four bricks, one at each corner. For round valve boxes, support with two bricks on opposing sides.

D. Refer to details on irrigation detail sheet.

3.7 CONTROLLER AND ELECTRICAL INSTALLATION

A. Make final connection of 110-volt service to timer. 110-volt service to timer location to be coordinated with electrical trades.

B. Install surge protection and grounding equipment as recommended by controller manufacturer.
C. Install control cable/wire in same trench as irrigation piping and beside piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install electrical control wire in the pipe trenches wherever possible.

D. Install cable/wire with 24” of slack so as to provide for expansion and contraction. Expansion joints in wire may be provided at two hundred-foot (200’) intervals by making 5-6 turns of the wire around a piece of half inch (1/2”) pipe. Where necessary to run wire in a separate trench, provide a minimum cover of twenty-four inches (24”).

E. Provide minimum twenty-four-inch (24”) slack at remote control valves to allow raising the valve bonnet or splice to the surface, without disconnecting the wire, for repair.

F. Provide minimum of 5'-0” of slack at all wire splices and spare wire locations. Neatly tape wire together using duct tape and coil it in a neat bundle within the valve box.

G. Connect each remote-control valve to one station of a controller except as otherwise indicated. Where there is to be more than one valve per station. Make required splice at the control timer.

H. Make splices only at valve, unless otherwise unavoidable. Locate all field splices on the as-built drawing. See detail on irrigation detail sheet for approved wire splice method.

I. All wire to be spliced using 3M scotch-lok or DBY/R-6 connectors as detailed on the irrigation detail sheet.

J. Install decoders per manufacturer’s recommendations.

K. Ground controller, cable, and decoders per manufacturer’s recommendations.

L. Obtain assistance from landscape contractor to set zone watering days and run time durations.

3.8 SPRINKLERS

A. Install sprinklers as detailed on the irrigation detail sheet.

B. Install nozzles as noted in the irrigation legend. All nozzles shall be by the sprinkler manufacturer.

3.9 MASTER VALVE / FLOW METER

A. Install master valve/flow meter as noted in the irrigation detail sheet. Obtain assistance from controller representative to ensure proper installation.

3.10 FLUSHING AND TESTING

A. After all new irrigation piping is in place and connected for a given section and all necessary division work has been completed, all control valves shall be opened and a full head of water used to flush out the system.

B. The sprinkler main shall be tested under normal water pressure (60 PSI) for a period of twelve hours. If leaks occur, repair and repeat the test. Give Owner's Representative twenty-four hours’ notice prior to testing.
C. Any necessary repairs shall be made, at the Contractor's expense, to put the system in good working order before final payment by the Owner.

3.11 FIELD QUALITY CONTROL

A. Control timer: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
   3. Central control and controller: After master valve, flow sensor and controller has been installed and connected via hardwire to each other and by communication to the internet, test system for complete and accurate operation.
   4. Provide one day to assist authorized manufacturer in downloading data and zone operation times for all zones on controller. Irrigation system will not be considered complete until control system is in complete working order.
   5. Test and adjust controls, pressure regulators and safeties. Replace damaged and malfunctioning controls and equipment.

C. Any irrigation product will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports for both controller systems.

E. Provide certificate of compliance from plumber licensed to perform certification on backflow preventers showing that the backflow preventer meets all local and State health codes. Certification must be on licensed plumber's letterhead and include signature of inspector and applicable licensed number(s).

F. Obtain assistance from landscape contractor to set zone operation times.

END OF SECTION 32 84 00
SECTION 32 91 13
SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes planting soils specified by composition of the mixes.

1.3 DEFINITIONS


B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

G. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

H. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

I. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.


L. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

M. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

N. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.


1.4 SUBMITTALS

A. Submittals to be made in accordance with Section 013300 “Submittal Procedures”.

B. Product Data: For each type of product.

1. Include recommendations for application and use.
2. Include test data substantiating that products comply with requirements.
3. Include sieve analyses for aggregate materials.
4. Material Certificates: For each type of soil amendment and fertilizer before delivery to the site, according to the following:
   a. Manufacturer's qualified testing agency's certified analysis of standard products.
   b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
   c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

C. Qualification Data: For each testing agency.

D. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent or state-operated or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1. Laboratories: Subject to compliance with requirements, provide testing by the following:
   a. Environmental/Hazardous Metals Testing:
      1) University Laboratories, 22530 Heslip Drive, Novi, MI 4837, 248-615-8000 (support@universitylaboratories.com)
      2) Or Approved Equal.
   b. Soil Physical Testing:
1) Turf and Soil Diagnostics, 35 King Street, Trumansburg, NY 14886, 855-769-4231 (lab@turfdiag.com)
2) Or Approved Equal

c. Soil Fertility Testing
1) CLC Labs, 325 Venture Drive, Lewis Center, OH 43035, 614-888-1663 (clclabs@aol.com)

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil.

1. Notify Architect seven days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.7 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Architect under the direction of the testing agency.

1. Number and Location of Samples: Minimum of eight representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.
2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.8 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."


C. Chemical Testing:

1. Metals Hazardous to the Environment: Test for presence and quantities of RCRA metals including, arsenic, barium, cadmium, chromium, lead, and mercury. If RCRA metals are present, include recommendations for corrective action.

2. Metals Hazardous to Human Health: Test for the presence and quantities of the USEPA 503 metals, including arsenic, cadmium, copper, lead, mercury, nickel, selenium, and zinc. Reports levels found in comparison to allowable levels according to Table 3 of 503.13.

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT NCR-13, including the following:

1. Percentage of organic matter (LOI at 360°C or 440°C).

2. CEC, calcium percent of CEC, and magnesium percent of CEC.

3. Soil reaction (acidity/alkalinity pH value).

4. Buffered acidity or alkalinity.


6. Phosphorous ppm.

7. Potassium ppm.

8. Calcium ppm.


10. Iron ppm.

11. Manganese ppm.

12. Zinc ppm.

13. Copper ppm.


15. Boron ppm.


E. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable tree, shrub, and perennial planting indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm) depth of soil.

2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm) depth of soil.
1.9 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Do not move or handle materials when they are wet or frozen.
   4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.

B. Existing Soil: On-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil with soil amendments, fertilizers, and lime in quantities as recommended based on Testing reports.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   1. Class: O, with a minimum of 95 percent passing through a No. 8 (2.36-mm) sieve and a minimum of 55 percent passing through a No. 60 (0.25-mm) sieve.
   2. Form: Provide lime in form of ground calcitic limestone.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 (0.30-mm) sieve.
F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
   1. Reaction: pH of 5.5 to 8.
   2. Soluble-Salt Concentration: Less than 4 dS/m.
   3. Moisture Content: 35 to 55 percent by weight.
   5. Particle Size: Minimum of 98 percent passing through a 1-inch (25-mm) sieve.

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 33 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

C. Proceed with placement only after unsatisfactory conditions have been corrected.
3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches (150 mm) and stockpile until amended.

B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

C. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches (150 mm). Remove stones larger than 2 inches (50 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 4 inches (100 mm) of subgrade. Spread remainder of planting soil.

C. Mixing: Spread unamended soil to total depth of 6 inches (150 mm), but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
   a. Mix lime and sulfur with dry soil before mixing fertilizer.
   b. Mix fertilizer with planting soil no more than seven days before planting.

2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 6 inches (150 mm) in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 PROTECTION

A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."
B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation or other digging unless otherwise indicated.

C. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.5 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

END OF SECTION 32 91 13
TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Seeding.
   2. Turf Renovation.

B. Related Sections:
   1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
   2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
   3. Division 32 Section "Fine Grading" for final grades for planting.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

C. Certification of Bio-Retention Area Seed: From seed vendor for each bio-retention-seed monostand or mixture stating the botanical and common name and percentage by weight of...
each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

D. Product Certificates: For fertilizers, signed by product manufacturer.

E. Qualification Data: For landscape Installer.

F. Material Test Reports: For imported topsoil.

G. Planting Schedule: Indicating anticipated planting dates for each type of planting.

H. Maintenance Instructions: Recommended procedures to be established by Contractor for the Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; location exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.

1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's “Specifications for Turfgrass Sod Materials” and “Specifications for Turfgrass Sod Transplanting and Installation” in its “Guideline Specifications to Turfgrass Sodding.”

1.7 SCHEDULING

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: April 1st and June 1st.
2. Fall Planting: September 15th and October 15th.
B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Seeded Lawns: 60 days from date of Substantial Completion.

   a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.

   b. A minimum of two (2) lawn cuttings (MANICURED LAWN ZONES ONLY) will be completed before the owner takes over maintenance.

B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.

   1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.

   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

   2. Water lawn at a minimum rate of 1 inch per week.

D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

   1. Mow grass to 2 inches height.

E. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

   1. Apply Type B fertilizer to lawns approximately 30 days after seeding at a rate equal to 1.0 lb. of actual nitrogen per 1,000 sq. ft. (140 lbs./acre). Apply with a mechanical rotary or drop type distributor. Thoroughly water into soil. (Provide 3 applications)

F. Weed Control: If an infestation of weeds or crab grass develops prior to acceptance of the lawn, the Contractor shall treat the infestation by hand weeding or chemical control. The chemical control shall be furnished and installed by the contractor as recommended by the manufacturer and approved by the Landscape Architect. At least two weeks shall elapse af-
G. Apply fungicides and insecticides as required to control diseases and insects.

H. Coordinate with Section 02940 Landscape Maintenance and Warranty Standards.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA’s “Journal of Seed Technology; Rules for Testing Seeds” for purity and germination tolerances.

B. Seed shall be provided from one of the following suppliers
   1. Lesco (248) 689-5005
   2. Rhino Seed & Supply (800) 482-3130
   3. Michigan State Seed Solutions (800) 647-8873

C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
   1. General Seeded Lawn Areas (for lawn restoration areas only):
      a. 50 percent Kentucky Bluegrass, a minimum of (3) three cultivars
      b. 50 percent Perennial Ryegrass, a minimum of (2 or 3) two or three cultivars.

2.2 TURFGRASS SOD

A. Turfgrass Sod: Certified Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with TPI’s “Specifications for Turfgrass Sod Materials” in its “Guideline Specifications to Turfgrass Sodding.” Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
   1. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars

2.3 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

   1. Topsoil Source: Import topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.
2.4 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
   1. Class: Class T, with a minimum 99 percent passing through No. 8 sieve and a minimum 75 percent passing through No. 60 sieve.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.

G. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.5 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 60 percent of dry weight.
   2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Peat: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.

C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.6 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.7 FERTILIZER

A. Granular, non-burning product composed of not less than 50% organic slow acting, guaranteed analysis professional fertilizer.
1. Type A: Starter fertilizer containing 11% nitrogen, 23% phosphoric acid, and 10% potash by weight or similar approved composition.

2. Type B: Top dressing fertilizer containing 31% nitrogen, 3% phosphoric acid, and 10% potash by weight or similar approved composition.

   a. Apply Type A fertilizer at initial sowing of seed and a Type B fertilizer application 4 weeks after initial germination.

   b. (Provide a min. one (1) Type A fertilizer application and three (3) Type B fertilizer applications)

2.8 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

D. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.9 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

2.10 PLANTING SOIL MIX

A. Planting Soil Mix: Mix topsoil with the following soil amendments in the following quantities:

   PLANTING BEDS:
   1. Three parts well-drained screened organic imported topsoil to one part clean imported sand to one part Canadian sphagnum peat moss, to one part natural compost (weed-free).
   
   LAWNs:
   2. Manicured Lawns shall use screened stock-piled topsoil from specified on-site location.
2.11 SEEDING
A. General: Provide grasses for seeding.

2.12 MATERIALS
A. Topsoil for Seeding Lawn Areas.
B. Seed: Fresh, clean and new crop seed mixture. Mixed by approved methods.
C. Composed of the following varieties, mixed to the specified proportions by weight and tested to minimum percentages of purity and germination.
D. Seed Mixture: Proportioned by weight as indicated below:

1. Type 1: All Sports Mix

<table>
<thead>
<tr>
<th>Seed Variety</th>
<th>Proportion</th>
<th>Minimum Purity</th>
<th>Minimum Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merit Kentucky Bluegrass</td>
<td>25%</td>
<td>95%</td>
<td>80%</td>
</tr>
<tr>
<td>Baron Kentucky Bluegrass</td>
<td>25%</td>
<td>95%</td>
<td>80%</td>
</tr>
<tr>
<td>Manhattan II Turf Type Rye</td>
<td>50%</td>
<td>95%</td>
<td>80%</td>
</tr>
</tbody>
</table>

a. Spread at a rate of 4-5 lbs./1000 sf.

2. Type 2: All Sports Mix

<table>
<thead>
<tr>
<th>Seed Variety</th>
<th>Proportion</th>
<th>Minimum Purity</th>
<th>Minimum Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrangler Turf Type Tall Fescue</td>
<td>40%</td>
<td>95%</td>
<td>80%</td>
</tr>
<tr>
<td>Newport Kentucky Bluegrass</td>
<td>40%</td>
<td>95%</td>
<td>80%</td>
</tr>
<tr>
<td>Allaire II Perennial Rye</td>
<td>20%</td>
<td>95%</td>
<td>80%</td>
</tr>
</tbody>
</table>

a. Spread at a rate of 6-7 lbs./1000 sf.

b. No noxious weed seeds permitted.

3. Type 3: Lawns
a. Seed Mixture: Proportioned by weight as indicated below:

<table>
<thead>
<tr>
<th>Seed Variety</th>
<th>Proportion</th>
<th>Minimum Purity</th>
<th>Minimum Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merit Kentucky Bluegrass</td>
<td>40%</td>
<td>95%</td>
<td>80%</td>
</tr>
<tr>
<td>Creeping Red Fescue</td>
<td>30%</td>
<td>95%</td>
<td>80%</td>
</tr>
<tr>
<td>Nite Hawk Perennial Rye Grass</td>
<td>30%</td>
<td>95%</td>
<td>80%</td>
</tr>
</tbody>
</table>
a. Spread at a rate of 4-5 lbs./1000 sf.
b. No noxious weed seeds permitted.

4. Type 3: “Low-Mow”

a. Seed Mixture: Proportioned by weight as indicated below:

<table>
<thead>
<tr>
<th>Seed Mixture</th>
<th>Proportion</th>
<th>Minimum Purity</th>
<th>Minimum Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chewing Fescue</td>
<td>24.5%</td>
<td>95%</td>
<td>80%</td>
</tr>
<tr>
<td>Axay Sheep Fescue</td>
<td>24.5%</td>
<td>95%</td>
<td>80%</td>
</tr>
<tr>
<td>Brigade Hard Fescue</td>
<td>24.5%</td>
<td>95%</td>
<td>80%</td>
</tr>
<tr>
<td>Creeping Red Fescue</td>
<td>12.5%</td>
<td>95%</td>
<td>80%</td>
</tr>
<tr>
<td>Dawson Red Fescue</td>
<td>12.5%</td>
<td>95%</td>
<td>80%</td>
</tr>
<tr>
<td>Inert matter</td>
<td>1.70%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other crop seed</td>
<td>0.30%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Sow seed at 5 lbs/1000 sf
b. No noxious weed seeds permitted.

E. Fertilizer: 13-25-12. Granular, non-burning product composed of not less than 50% organic slow acting, guaranteed analysis, professional fertilizer.

F. Ground Limestone: Used if required by soil test report. Containing not less than 85% of total carbonates and ground to such fineness that 50% will pass through a 100 mesh sieve and 90% will pass through a 20% mesh sieve.

G. Granulated sulfur 0-0-0-90 to lower pH. Use if determined by soil tests to be necessary. Apply per soil test recommendations at specified rate.

H. Straw Mulch: Used in crimping process only. Clean oat or wheat straw well seasoned before bailing, free from mature seed-bearing stalks or roots of prohibited or noxious weeds.

I. Water: Free of substance harmful to seed growth. Hoses or other methods of transportation furnished by Contractor. Test for excess Alkalinity, if necessary.

J. Wood Cellulose Fiber Mulch: Degradable green dyed wood cellulose fiber or 100% recycled long fiber pulp, free from weeds or other foreign matter toxic to seed germination and suitable to hydra-mulching.

1. AVAILABLE MANUFACTURER AND TYPE:
2. CONWED HYDROMULCH: CONWED CORP., ST. PAUL, MN
3. CELLIN HYDROMULCH: CELLIN MFG. INC., LORTON, VA

K. Paper Mulch: Degradable paper mulch, free of foreign debris. Do not use on slopes over 30%. Available manufacturer and type NU Wool Hydro Mulch, Jennison, MI.

L. Tackifier: Liquid concentrate diluted with water forming a transparent 3-dimensional film like crust permeable to water and air and containing no agents toxic to seed germination.

1. AVAILABLE MANUFACTURER AND TYPE:
2. FINN HYDROSTIK, FAIRFIELD, OH

3. POLYING DLR: CELITE INC., CLEVELAND, OH

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydro-seeding overspray.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LAWN PREPARATION

A. Limit lawn subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

   a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
   b. Mix lime with dry soil before mixing fertilizer.

2. Spread lawn planting soil mix to a depth of 3 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

C. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least of 6 inches.
3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/4 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.

E. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.4 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

   1. Lay sod across angle of slopes exceeding 1:3.
   2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.5 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

   1. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at the rate of 4-5 lb/1000 sq. ft. as indicated per specified seed mix.

C. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:6 with erosion-control fiber mesh and 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.

   1. Anchor straw mulch by crimping into topsoil with suitable mechanical equipment.
3.6 TURF RENOVATION

A. Renovate existing lawn.

B. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
   1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.

C. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.

D. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.

E. Mow, dethatch, core aerate, and rake existing lawn.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.

J. Apply seed and protect with straw mulch as required for new lawns.

K. Water newly planted areas and keep moist until new lawn is established.

3.7 MULCHING

A. Place straw mulch on seeded areas within twenty-four (24) hours after seeding.

B. Place straw mulch uniformly in a continuous blanket at a rate of 2-1/2 tons per acre or two (2) 50 lb. bales per 1,000 sq. ft. of area. A mechanical blower may be used for straw mulch application when acceptable to the Architect.

C. Crimp straw into soil by use of a “crimper.” Two (2) passes in opposite direction required.

3.8 SLIT SEEDING (OPTIONAL METHOD)

A. Lawn to be professionally slit seeded by using equipment designed for this purpose. Recommended brands: Brilliant, Jacobsen or Olathe.
3.9 HYDROSEEDING (OPTIONAL METHOD)

A. Use a hydromulcher (sprayer) and apply mixture(s) at the following rate. Mix in accordance with manufacturer’s recommendations.

B. Apply hydroseed slurry to indicated areas. Use tackifier only on erosion prone areas. Apply fertilizer with hydro mix.

<table>
<thead>
<tr>
<th>Material</th>
<th>Application Details</th>
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<tbody>
<tr>
<td>Seed</td>
<td>At specified seeding rates (300 pounds per acre)</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>400 pounds per acre</td>
</tr>
<tr>
<td>Tackifier</td>
<td>60 gallons per acre</td>
</tr>
<tr>
<td>Wood Cellulose Fiber Mulch</td>
<td>2000 pounds per acre</td>
</tr>
</tbody>
</table>

C. Care must be taken not to get hydroseed materials on buildings, walks, roadways, plant beds, etc.

3.9 SATISFACTORY LAWNS

A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 4 by 4 inches.

3.10 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

C. Remove erosion-control measures after grass establishment period.

END OF SECTION 329200
TOPSOIL (LANDSCAPING)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Extent of Topsoil Work is shown on drawings and by provisions of this section.

B. Topsoil for lawn work shall be as stripped from site or provided by contractor from off-site sources free of herbicides.

C. Related work specified elsewhere:
   1. Division 32 8400 Section “Planting Irrigation.”
   2. Division 32 9210 Section “Lawns and Grasses.”
   3. Division 32 9215 Section “Trees, Shrubs, Plants and Ground Covers.”

1.3 QUALITY ASSURANCE

A. Testing and Inspection: For supplied or stockpiled topsoil. Performed by a qualified independent testing laboratory, under the supervision of a registered professional engineer, specializing in soils engineering. Obtain samples from interior of stockpiled topsoil.

B. Soil originating from corn fields shall not be used unless the fields have not grown corn for a minimum of two (2) years. Soil testing must verify the levels of dangerous elements in the soil. Soil testing results shall be reviewed by the Landscape Architect prior to topsoil being delivered to the site.

C. Provide and pay for testing and inspection during topsoil operations. Laboratory, inspection services and Soils Engineer shall be acceptable to the Landscape Architect.

   1. Recommended testing laboratory:
      A & L Agricultural Laboratories, Inc.
      3505 Conestoga Drive
      Fort Wayne, IN  46808
      (219) 483-4759

D. Test representative material samples for proposed use.

E. Topsoil: (Supplied and Stockpiled – See Materials 2.1)

   1. pH factor
   2. Lime requirement
   3. Mechanical analysis (P.K. Ca. mg) and cation ratios
   4. Percentage of organic content and loss of ignition
   5. Soil series classification
   6. Clay content
7. Herbicide residue

F. Recommendations on type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.

G. Submit test reports.

1.4 PROJECT CONDITIONS

A. Known underground and surface utility lines are indicated on the drawings.

B. Protect existing trees, plants, lawns and other features designated to remain as part of the landscaping work.

C. Promptly repair damage to adjacent facilities caused by topsoil operations.

D. Promptly notify the Landscape Architect of unexpected sub-surface conditions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil: Supplied or stockpiled topsoil proposed for use must meet testing criteria results specified and conform to adjustments as recommended by soil test and Landscape Architect.

B. Existing Topsoil: Existing topsoil from on-site stockpile shall be utilized. All processing, screening, cleaning and preparation of this stored topsoil to render it acceptable for use is the responsibility of the Contractor.

C. Provide additional topsoil as required to complete job. Topsoil must meet testing criteria results specified. All processing, cleaning and preparation of this stored topsoil to render it acceptable for use is the responsibility of this Contractor.

D. Supplied or stockpiled topsoil shall be fertile, friable and representative of local productive soil, capable of sustaining vigorous plant growth and screened free of clay lumps, subsoil, noxious weeds or other foreign matter such as stones greater than 1” in diameter in any dimension, roots, sticks and other extraneous materials not frozen or muddy. pH of existing or supplied soil to range between 5.0 and 7.5. Adjusted to not more than 7.0 by additives as required by soil test. Topsoil shall contain not less than 3% and not greater than 10% organic matter. Clay content as determined by Bouyoucous Hydrometer Test shall range between 5 and 15 percent. Mechanical analysis as follows:

<table>
<thead>
<tr>
<th>PASSING</th>
<th>RETAINED ON</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot; Screen</td>
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<td></td>
</tr>
<tr>
<td>1&quot; Screen</td>
<td>¼” screen (gravel)</td>
<td>Not more than 3%</td>
</tr>
<tr>
<td>¼” Screen</td>
<td>No. 140 USS Mesh Sieve</td>
<td>40-60%</td>
</tr>
<tr>
<td>No. 140 USS</td>
<td>Percentage based on day weight</td>
<td>30-35% (Very fine sand, silt and clay)</td>
</tr>
<tr>
<td></td>
<td>of the samples</td>
<td></td>
</tr>
</tbody>
</table>

32 9220 - 2 TOPSOIL (LANDSCAPING)
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough grades and installation conditions. Do not start topsoil work until unsatisfactory conditions are corrected.

3.2 FINISH GRADING

A. Perform topsoiling within contract limits, including adjacent transition areas, to new elevations, levels, profiles, and contours indicated. Provide uniform levels and slopes between new elevations and existing grades.

B. Grade surfaces to assure areas drain away from building structures and to prevent ponding and pockets of surface drainage.

C. Lawn Areas: Supply and spread topsoil to a minimum uniform depth of 4” or as noted. Incorporate into existing subsoil by disc, rototill or other approved method to a minimum 6” depth. No layering of soils is to exist after tilling. Remove clumps larger than 1” in diameter.

D. Grade lawn areas to a smooth, free draining even surface with a loose, moderately coarse texture ready to accept seed or sod.

E. For trees, shrubs, ground cover beds and backfill for beds see Trees, Plants and Ground Cover Section.

F. Provide earth crowning where indicated on drawings.

G. Crowning/mounding to be free flowing in shape and design, as indicated, and to blend into existing grades gradually so that toe of slope is not readily visible. Landscape Architect to verify final contouring before planting.

H. Regardless of finish grading elevations indicated, it is intended that grading be such that proper drainage of surface water will occur and that no low areas are created to allow ponding. Contractor to consult with Owner or Landscape Architect regarding minor variations in grade elevations before rough grading is completed.

3.3 LAWN ESTABLISHMENT

A. Establish dense lawn of permanent grasses, free from lumps and depressions. Any area failing to show uniform germination to be reseeded; continue until dense lawn established. Damage to seeded area resulting from erosion to be repaired by Contractor. Scattered bare spots over 5 percent now allowed.

B. In event contractor does not establish dense lawn during germination period, return to project to refertilize and reseed to establish dense lawn.

C. Should the seeded lawn become largely weeds after germination, Contractor is responsible to kill the weeds and reseed the proposed lawn areas to produce a dense turf, as specified.

3.4 CLEANING

A. Upon completion of topsoiling operations, clean areas within contract limits, remove tools and equipment. Site shall be clear, clean, free of debris and suitable for site work operations.
 Gateway Theater Complex – Utilities
 HAA Project No. 2016034.00
 WSU Project No. 189-178578

 END OF SECTION  329220
SECTION 32 93 00

PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Tree stabilization.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

E. Finish Grade: Elevation of finished surface of planting soil.

F. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscsicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

G. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

H. Planting Area: Areas to be planted.
I. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for drawing designations for planting soils.

J. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

K. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

L. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

M. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: For each phase of landscape installation, Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Samples for Verification: For each of the following:

1. Trees and Shrubs: Three samples of each variety and size delivered to site for review. Maintain approved Samples on-site as a standard for comparison.
2. Organic Mulch: 1-pint volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
3. Mineral Mulch: 1-pint of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on-site; provide an accurate indication of color, texture, and makeup of the material.
4. Root Barrier: Width of panel by 12 inches (300 mm).

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
   1. Manufacturer's certified analysis of standard products.
   2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

D. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
   1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
   2. Experience: Five years’ experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
   3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
      a. Landscape Industry Certified Technician - Exterior.
      b. Landscape Industry Certified Interior.
      c. Landscape Industry Certified Horticultural Technician.
   5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.

2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials two weeks in advance of delivery to site.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk materials with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.11 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

2. Fall Planting: October 15.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
   b. Structural failures including plantings falling or blowing over.

2. Warranty Periods: From date of planting completion.
   a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
   b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.

3. Include the following remedial actions as a minimum:
a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.

2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood.
2. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.
2.3 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.4 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects. Dimensions as indicated on Drawings.

2.5 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.

C. Planter Filter Fabric: Nonwoven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.

3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Placing Planting Soil: Place manufactured planting soil over exposed subgrade.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit.

2. Excavate approximately three times as wide as root ball diameter.

3. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.

4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.

5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.

6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.

7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected after working hours.
9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
   1. Hardpan Layer: Drill 6-inch-diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.
   2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
   3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.
   2. Carefully remove root ball from container without damaging root ball or plant.
   3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
PLANTS 32 93 00 - 10

E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 MECHANIZED TREE-SPADE PLANTING

A. Trees may be planted with an approved mechanized tree spade at on grade locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

B. Use the same tree spade to excavate the planting hole as will be used to extract and transport the tree.

C. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

D. Cut exposed roots cleanly during transplanting operations.

E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.

F. Where possible, orient the tree in the same direction as in its original location.

3.7 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

A. Trunk Stabilization by Upright Staking and Tying: as indicated on Drawings.

3.9 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings.

B. Use Planting Soil for backfill.

C. Dig holes large enough to allow spreading of roots.
D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.10 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Organic Mulch in Planting Areas: Apply 3-inch over whole surface of planting area and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.11 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.13 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same size and species as those being replaced.

3.14 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.15 MAINTENANCE SERVICE

A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: 12 months from date of Substantial Completion.

B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: Six months from date of Substantial Completion.

END OF SECTION 32 93 00
LANDSCAPE MAINTENANCE AND WARRANTY STANDARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The requirements of this section include a one (1) year warranty period from date of acceptance of installation.

B. Related work specified elsewhere:
   1. Division 32 9210 Section "Lawns and Grasses."

1.3 ACCEPTANCE OF INSTALLATION

A. At the completion of all landscape installation, or pre-approved portions thereof, the Landscape Contractor shall request in writing an inspection for acceptance of installation in which the Landscape Contractor, Landscape Architect and Owner’s Representative shall be present. After this inspection a “Punch List” will be issued by the Landscape Architect and/or Owner’s Representative. The Landscape Architect and/or Owner’s Representative shall re-inspect the project and issue a written statement of acceptance of installation and establish the beginning of the project warranty period.

B. It is the responsibility of the Landscape Contractor to make the above written request for inspection of installation in a timely fashion. If there is plant material loss prior to the Landscape Contractor’s written request for inspection of installation, the Landscape Contractor shall make all replacements of this dead material at no additional cost. These replacements are not considered to be the required one (1) replacement of dead plant material by the Landscape Contractor during the one (1) year project warranty period, as outlined below.

C. Landscape work may be inspected for acceptance in parts agreeable to Owner’s Representative and Landscape Architect provided work offered for inspection is complete, including maintenance as required.

D. For work to be inspected for partial acceptance, Contractor shall provide a drawing outlining work completed, and supply a written statement requesting acceptance of this work completed to date.

1.4 PROJECT WARRANTY

A. The project warranty period begins upon written acceptance of the project installation by Landscape Architect and Owner’s Representative.
B. The Landscape Contractor shall guarantee trees, shrubs, ground cover bed, and seeded or sodded areas through construction and for a period of one (1) year after date of acceptance of installation against defects including death and unsatisfactory growth, except for defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are beyond Landscape Contractor’s control.

C. The cost of replacements is at the Contractor’s expense. Warranty all replacement plants for one (1) year after installation acceptance. Every plant that is replaced under warranty shall again be guaranteed for one (1) full year from date of Owner’s acceptance.

D. Warranty: One (1) year from date of Owner’s acceptance.

1.5 MAINTENANCE

A. Arrange with the Owner’s Representative to walk the site monthly during the warranty period to review the maintenance standards. Written minutes of this meeting shall be furnished to the Owner and the Landscape Architect.

B. To insure guarantee standards, the following maintenance procedures shall be executed during construction and for the full project warranty period.

C. Maintenance of Trees, Shrubs, and Ground Covers:

1. Landscape Contractor shall be responsible for replacement of any plant materials that are dead or in the opinion of the Landscape Architect are in an unhealthy or unsightly condition, or having lost natural shape, resulting from dieback, excessive pruning or inadequate or improper maintenance as part of the guarantee. Prior to any replacements Landscape Contractor shall review individual plants in question with Landscape Architect and determine the reason for plant demise. The replacement shall be guaranteed for 1 year (same as initial plantings). A plant shall be replaced as many times as necessary until it lives for a minimum of one (1) year.

2. Replacements must meet specifications i.e. quality, species of plant material and planting procedures to receive approval of replacement materials by Landscape Architect.

3. Costs for replacements are assumed part of bid quotations and therefore will not result in an additional cost to Owner or Landscape Architect.

4. Areas damaged as result of replacement operations are to be restored by Contractor at no cost to the Owner or Landscape Architect.

5. The contractor shall be responsible for watering all plantings through the warranty period and shall keep guy wires taut, raise tree balls which settle, furnish and apply sprays as necessary to keep the plantings free of disease and insects until the end of the warranty period. All evergreens shall be watered thoroughly in the fall to insure they do not go into the winter dry. Arrange with Owner’s Representative to walk the site monthly during warranty period to review maintenance standards. Remove and replace trees, shrubs, or other plants and materials promptly. Make replacements during following normal planting schedule. Replace trees and shrubs which are in doubt, unless, in opinion of Owner’s Representative and Landscape Architect it is advisable to extend warranty period for a full-growing season. Remove all stakes, guy wires, tree wrap paper, dead twigs and branches from tree and plant materials at the end of this warranty period. Keep planting beds free of weeds during guarantee period.

D. Maintenance of Sodded Lawn Areas:

1. Water sod thoroughly as required to establish proper rooting.
2. The Contractor shall establish a dense lawn of permanent grasses free from lumps and depressions. Repair, rework and resod all areas that have washed out or are eroded. Replace undesirable or dead areas with new sod.

3. Mow lawn areas as soon as lawn top growth reaches a 3” height. Cut back to 2” height. Repeat mowing as required to maintain specified height. Not more than 40% of grass leaf shall be removed at any single mowing.

4. The Contractor shall provide a minimum of two cuttings of the lawn or more as necessary until the inspection and acceptance of installation by the Owner's Representative and Landscape Architect. When the lawn reaches 3 inches in height it shall be cut to 2 inches in height. Contractor shall notify the Owner’s Representative and Landscape Architect in writing one (1) week in advance of the final lawn cutting to allow the Owner and the Landscape Architect to inspect the lawns and schedule Owner's maintenance work.

5. The Owner assumes cutting responsibility following the acceptance of installation by the Owner's Representative and the Landscape Architect.

6. After acceptance of installation, and for the duration of the project warranty period, the Landscape Contractor shall continue all other maintenance procedures including fertilizing and weeding, and other operations such as rolling, regrading, replanting, and applying herbicides, fungicides, insecticides as required to establish a smooth, acceptable lawn free of eroded or bare areas.

7. Apply three (3) applications of Type “B” fertilizer once in every seven to eight (7-8) week intervals. These applications shall be in addition to fertilizer applied for the soil preparation. The first application shall be applied on or about thirty (30) days after seeding. Contractor to time the applications in conjunction with anticipated rain. If initial seeding takes place in late fall, begin fertilizing applications very early at onset of the following spring season.

8. At conclusion of project warranty period and after reviewing written final acceptance by Owner’s Representative and Landscape Architect, the Owner shall assume all lawn maintenance responsibilities.

E. Maintenance of Seeded Lawn Areas:

1. The Contractor shall establish a dense lawn of permanent grasses, free from lumps and depressions or any bare spots, none of which is larger than one foot of area up to a maximum of 3% of the total seeded lawn area. Any part of the seeded lawn that fails to show a uniform growth and/or germination shall be reseeded until a dense cover is established.

2. If seeded in fall or if not considered acceptable at that time, continue maintenance the following spring until acceptable lawn is established.

3. The Contractor shall provide a minimum of two (2) cuttings of the lawn or more as necessary until the inspection and acceptance of installation by the Owner’s Representative and Landscape Architect. When the lawn reaches 3 inches in height, it shall be cut to 2 inches in height.

4. The Owner assumes cutting responsibilities following the acceptance of installation by the Owner’s Representative and the Landscape Architect.

5. After acceptance of installation, and for the duration of the project warranty period the Landscape Contractor shall continue all other maintenance procedures including fertilizing and weeding, and other operations such as rolling, regrading, replanting, and applying herbicides, fungicides, insecticides as required to establish a smooth, acceptable lawn free of eroded or bare areas.

6. Repair, rework, and re-seed all areas that have washed out, and eroded, or do not substantially germinate.

7. At conclusion of project warranty period and after receiving written final acceptance by Owner’s Representative and Landscape Architect, the Owner shall assume all seeded lawn maintenance responsibilities.
1.6 FINAL ACCEPTANCE

A. At the conclusion of the project warranty period, the Landscape Contractor shall request a project inspection for final acceptance in which the Landscape Contractor, Landscape Architect and Owner’s Representative shall be present. After this inspection a “Punch List” will be issued by the Landscape Architect. Upon completion of all punch list items, the Landscape Architect and Owner’s Representative shall reinspect the project and issue a written statement of final acceptance. Upon final acceptance the Owner assumes all maintenance responsibilities for the landscape of the project.

END OF SECTION 32 9400
SECTION 331100 - WATER MAIN

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Where these specifications differ from the standard details or specifications of the governing agency, the agency standards shall apply.

B. Materials and installation requirements are generally indicated on the plans. Materials indicated in these specifications only apply if indicated on the plans and allowed by the regulating authority. Contractor is responsible for confirming allowable materials and installation requirements with the regulating authority and including these requirements in their bid.

C. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for the water supply system (for both fire protection and domestic water systems).

B. Water meters may be provided by the regulating authority. Contractor shall confirm with the regulating authority and pay the required fees for the meter.

1.3 DEFINITIONS

A. EPDM: Ethylene propylene diene terpolymer rubber.

B. HDPE: High density polyethylene plastic

C. PVC: Polyvinyl chloride plastic.

D. DI – Ductile Iron.

1.4 SUBMITTALS

A. Product Data and shop drawing submittals are not required. Contractor shall confirm that the materials provided meet the requirements of the regulating authority, and provide material certification to the engineer. Material certification shall state that the products meet or exceed the requirements indicated on the plans and the requirements of the regulating authority.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Comply with requirements of utility company supplying water, including materials, installation, tapping of water mains, testing, and disinfection.

   B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

   A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

      1. Ensure that valves are dry and internally protected against rust and corrosion.
      2. Protect valves against damage to threaded ends and flange faces.
      3. Set valves in best position for handling. Set valves closed to prevent rattling.

   B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

      1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
      2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

   C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

   D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

   E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

   F. Protect flanges, fittings, and specialties from moisture and dirt.

   G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

   A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

      1. Notify construction manager (or architect if there is no construction manager) no fewer than three days in advance of proposed interruption of service.
      2. Do not proceed with interruption of water-distribution service without construction manager’s or architect’s written permission.

1.8 COORDINATION

   A. Coordinate connection to water main with utility company and make connection per their requirements.
PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
   2. Copper, Pressure-Seal Fittings:
      a. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
      b. NPS 2-1/2 (DN 65) Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

B. Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.
      a. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
      b. NPS 2-1/2 (DN 65): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

D. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.2 GATE VALVES

A. AWWA, Gate Valves:
   1. Available Manufacturers: Subject to compliance with requirements of the regulating authority.
   2. Stem (rising or non-rising), and Gate Valve seating (metal seated or resilient seated) to meet requirements of the regulating authority and/or as shown on the standard detail sheets included with the plan:

2.3 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:
   1. Available Manufacturers: Subject to compliance with requirements of the regulating authority.
   2. Description: Sleeve and valve compatible with drilling machine.
a. Standard: MSS SP-60.
b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
c. Valve: per requirements of regulating authority.

B. Valve Boxes: If requirements are not indicated on the plans or standard detail sheets, comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering “WATER,” and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts (only if indicated on the plan or required by the regulating authority): UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.4 WATER METERS

A. Water meters will be furnished by utility company.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Earth Moving“ for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications and in accordance with the regulating authority. Where these specifications differ from the requirements of the regulating authority, those requirements shall govern.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping [NPS 3/4 to NPS 2 1/2] shall be the following:

1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings.

F. Underground watermain piping [NPS 4 to NPS 16] shall be as indicated in the plans and standard detail sheets, and as allowed by the regulating authority:
3.3 VALVE APPLICATIONS

A. General Application: As indicated in the plans and standard detail sheets, and as allowed by the regulating authority.

3.4 PIPING INSTALLATION

A. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated. Include valve in box per City requirements. Coordinate with the water utility company to provide necessary inspection of watermain installation.

B. Bury piping with depth of cover over top at least 60 inches but not less than the minimum required by the regulating authority.

C. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed. These locations will be indicated on the plans, however, the contractor can propose this installation method in areas where it would be beneficial to minimize disturbance to existing conditions.

D. Extend water-service piping to within 5' of the building wall. Coordinate with the interior plumbing plans and the construction manager, owner, or general contractor to confirm the location.

1. Terminate piping with caps, plugs, or flanges as required for piping material. Connections to building-water-piping systems will be done by the interior plumbing contractor.

E. Install underground piping with restrained joints and/or thrust blocks at horizontal and vertical changes in direction (as indicated on the standard detail sheets or as required by the regulating authority). Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.5 JOINT CONSTRUCTION

A. Make pipe joints according to the following:


2. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.6 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following (as long as the regulating authority approves of their use):

1. Concrete thrust blocks.
2. Locking mechanical joints.
4. Bolted flanged joints.
5. Pipe clamps and tie rods.
B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for all piping systems:

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box unless gate well is indicated on the plan.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

C. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.

3.8 CONNECTIONS

A. Connect water-distribution piping to existing water main. Use connection method indicated on the plan and as dictated by the regulating authority.

3.9 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests according to requirements of the regulating authority. If testing methods are not dictated by the regulating authority, test as follows: Conduct tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.10 IDENTIFICATION

A. If required by the regulating authority, install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving."
3.11 CLEANING

A. Clean and disinfect water-distribution piping in accordance with the requirements of the regulating authority. When requirements are not given, clean and disinfect as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
   a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
   b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
   c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
   d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 331100
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Where these specifications differ from the standard details or specifications of the governing agency, the agency standards shall apply.

B. Materials and installation requirements are generally indicated on the plans. Materials indicated in these specifications only apply if indicated on the plans and allowed by the regulating authority. Contractor is responsible for confirming allowable materials and installation requirements with the regulating authority and including these requirements in their bid.

C. Contractor shall follow all standards and details as directed by the City of Detroit Water and Sewerage Department.

D. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

A. This Section includes gravity-flow, nonpressure sanitary sewerage outside the building, with the following components:
   1. Cleanouts.
   2. Precast concrete manholes.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data and shop drawing submittals are not required. Contractor shall confirm that the materials provided meet the requirements of the regulating authority, and provide material certification to the engineer. Material certification shall state that the products meet or exceed the requirements indicated on the plans and the requirements of the regulating authority.

B. Field quality-control test reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.
C. Handle manholes according to manufacturer’s written rigging instructions.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements of the regulating authority.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

B. Materials are generally indicated on the plans. Materials indicated in these specifications only apply if indicated on the plans and allowed by the regulating authority. Contractor is responsible for confirming allowable materials and installation requirements with the regulating authority and including these requirements in their bid.

2.3 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings, NPS 8 and Smaller: ASTM D 3034, SDR 26, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

B. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794 pipe, with bell-and-spigot ends; ASTM D 3034 fittings, with bell ends; and ASTM F 477, elastomeric seals.

2.4 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M), Class IV, with groove and tongue ends for gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets
2.5 MANHOLEs

A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints. Refer to plans for standard detail.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
   a. Invert Slope: 1 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.
   a. Slope: 8 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.7 CLEANOUTS

A. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."
3.2 PIPING APPLICATIONS

A. Gravity-Flow, Nonpressure Sewer Piping: Pipe material is indicated on the plans. Use only pipe materials indicated on the plans and acceptable to the regulating authority.

3.3 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.

F. Install gravity-flow, nonpressure, sewer piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated on the drawings.
2. Install piping at depths indicated on the plans.
3. Install piping below frost line.
4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
5. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual".

3.4 PIPE JOINT CONSTRUCTION

A. Basic piping joint construction is specified in Division 22 Section "Common Work Results for Plumbing" Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

B. Join gravity-flow, nonpressure, piping according to the following:

1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
2. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints
3. Join dissimilar pipe materials with nonpressure-type, flexible couplings.
3.5 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.
B. Install precast concrete manhole sections with sealants according to ASTM C 891.
C. Form continuous concrete channels and benches between inlets and outlet.
D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops of manholes in lawn areas to the rim elevations indicated on the plan.

3.6 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318/318R.

3.7 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade.
   1. Use light-duty, top-loading classification cleanouts in earth areas.
   2. Use heavy-duty, top-loading classification cleanouts in paved areas.
B. Set with tops one inch above surrounding grade in nonpaved areas.
C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.8 CONNECTIONS

A. Extend sewer piping to within 5’ of building. Connection to building piping will be made by the plumbing contractor.
B. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   2. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
      a. Use concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
      b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.9 FIELD QUALITY CONTROL

A. Test new piping system according to requirements of regulating authority and provide test reports as required. If a testing method is not specified, test as follows:

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

C. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
   a. Allowable leakage is maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
   b. Close openings in system and fill with water.
   c. Purge air and refill with water.
   d. Disconnect water supply.
   e. Test and inspect joints for leaks.
   f. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 psig.

6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
   a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
   b. Option: Test concrete gravity sewer piping according to ASTM C 924.

D. Leaks and loss in test pressure constitute defects that must be repaired.
3.10 CLEANING

A. Clean interior of piping of dirt and superfluous material. Flush with potable water.

END OF SECTION 333100
SECTION 334100 - STORM SEWERS, UNDERDRAINS AND DRAINAGE STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 SUMMARY

A. The work under this Section includes, but is not necessarily limited to, the furnishing and installation of all storm sewers, underdrains and drainage structures and leads and connections as indicated on the Drawings, herein specified and as necessary for the proper and complete performance of this Work.

1. Storm Sewer Pipe
2. Castings
3. Manhole Sections and Steps
4. Catch Basin
5. Brick and Concrete Block Masonry

B. Related Sections may include, but not be limited to, the following:

1. Division 31 2000 Section “Earth Moving” for excavation and backfill.

1.3 QUALITY ASSURANCE

A. Use only personnel completely trained and experienced in installation of the materials.

B. Compliance to City/Township Codes and all other agencies having jurisdiction shall govern material and installation procedures.

1.4 SUBMITTALS

A. Shop Drawings: Submit product data for storm sewer materials. Contractor is expected to conform to the plans, specifications, and details for this work. Submit material certificates in lieu of shop drawings. Material certificates shall be signed by manufacturer and contractor certifying that each material item complies with or exceeds requirements.

B. Submittals and Resubmittals: Engineer will review each of Contractor’s shop drawings and/or submittal data the initial time and, should resubmittal be required, one additional time to verify that reasons for resubmittal have been addressed by Contractor and corrections made. Resubmittal changes/revisions/corrections shall be circled. Engineer will review only circled items and will not be responsible for non-circled changes/revisions/corrections and additions. Should additional resubmittals be required, Contractor shall reimburse Owner for all costs incurred, including the cost of Engineer’s services made necessary to review such additional resubmittals. Owner will in turn reimburse Engineer.

C. Requests for Information

1. Engineer reserves the right to reject any Request for Information (RFI) that the Engineer, at its sole discretion, deems frivolous.
2. Engineer reserves the right to reject any RFI that the Engineer, at its sole discretion, deems already answered in the Contract Documents.
3. RFI process shall not be used for requesting substitutions. Procedures for substitutions are clearly specified elsewhere in the Contract Documents.

1.5 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials before, during and after installation.
B. Replacements: In the event of damage, immediately make all necessary repairs and replacements acceptable to the Engineer and at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 STORM SEWER PIPE

A. General: Storm sewer pipe material shall be as indicated on the plans. If indicated on the plans, pipe materials shall conform to the following requirements.
B. Reinforced Concrete Pipe
   1. Reinforced concrete pipe shall conform to ASTM C-76.72A, Type III & Type IV.
   2. Joints shall be premium rubber joint as acceptable to the Engineer unless otherwise specified on the drawings.
C. Corrugated Polyethelene Tubing (CPT)
   1. Corrugated Polyethylene Tubing (CPT) shall conform to ASTM F405 and shall be perforated with sock where indicated on the plans.
   2. Joints shall be secured with a factory made snap-on or screen-on coupler for 4” and 6” diameter. Joints for 8” diameter and larger shall be a factory made coupler ties, bolts or screws on.
D. PVC Sewer Pipe and Fittings, NPS 10 (DN 375) and Smaller: ASTM D 3034, SDR 26 for 8” and smaller, SDR 35 for 10” and larger, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

2.2 CASTINGS

A. General: All castings shall be of cast iron, conforming to ASTM A 48 unless otherwise indicated. Conform to details and notes indicated on the plans. Where details or notes are not indicated, conform with the following requirements.
B. Manhole frames and covers: Material shall be MDOT Type A with perforated covers.
C. Catch basins and inlet castings: Catch basin and inlet castings shall be MDOT Type K when located in curbs and gutter, MDOT Type E in non-paved locations, and MDOT Type A when located in paved areas.

2.3 MANHOLE SECTIONS
A. Manhole walls
   1. Standard manhole walls shall be Precast concrete units conforming to ASTM C 478, or be concrete block masonry.

B. Manhole bases: Manhole bases shall be precast concrete units of the dimensions indicated on the Drawings.

2.7 MANHOLE STEPS

A. Manhole steps shall be of cast iron conforming to ASTM A 48 or equal, and shall meet pertinent safety rules and regulations.

2.8 CATCH BASINS

A. Construct catch basins of brick, block, masonry, or Precast units. Precast concrete catch basin units, if used, shall have reinforcing steel conforming to ASTM C 76 II, Wall B.

2.9 INLETS

A. Construct inlets of brick, block, masonry, or Precast units. Precast inlet units, if used, shall have reinforcing steel conforming to ASTM C 76 II, Wall B.

2.10 CLEANOUTS

A. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.11 MORTAR

A. Mortar for brick masonry or plastering manholes shall be made of one part Portland cement to two parts sand, and materials and mixing shall correspond, in general, to Division 04 2000 Section “Unit Masonry.”

2.12 BRICK

A. Brick Work shall meet the requirements of Medium Brick of ASTM C 13.

2.13 CONCRETE BLOCK MASONRY

A. Concrete block masonry shall conform to ASTM C 139.

2.14 OTHER MATERIALS

A. All other materials not specifically described but required for a complete and proper installation of the work of this Section, shall be new, first quality of their respective kinds, and as selected by the Contractor subject to review by the Engineer.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS
A. Inspection

1. Verify that all work under this Section may be installed in accordance with all pertinent codes and regulations, the original design and the reference standards.
2. All materials shall be inspected immediately before installation, and if found defective, immediately removed from the site.

B. Discrepancies

1. In the event of discrepancy, immediately notify the Engineer.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 EARTHWORK

A. All earthwork required for the performance of the work of this Section shall be installed in accordance with Division 31 2000 Section “Earth Moving.”

3.3 INSTALLATION

A. General: Install all pipe and fittings in strict accordance with the manufacturer's recommendations as acceptable to the Engineer and other authorities having jurisdiction.

B. Handling

1. Distribute pipe and materials at the site as required, care to prevent damage to the pipe and materials.
2. Use proper tools and implements for safely handling and installing the pipe and other materials.
3. Protect the pipe and other materials from falling to the ground or into the trench.
4. Protect distributed pipe and materials from the public and passing vehicles.

C. Laying pipe

1. Lay all pipe true to line and grade with pipe ends abutting each other and the bell end facing the direction of laying.
2. Use laser alignment equipment to establish and maintain proper line and grade, unless otherwise directed.
3. Correct any deviation from line and grade at no additional cost to the Owner.
4. Protect workers at all times from cave-in and other hazardous conditions.

D. Joints: Inspect each joint immediately after being completed and, if defective, shall be corrected before any more pipe is laid.

E. Manholes

1. Construct manholes as indicated on the Drawings and Specifications.
2. Take special care in forming the channels in the concrete bottom and use wooden templates or half sewer pipe for this work.
3. Plaster masonry work and castings as indicated on the Drawings.
4. In precast concrete manholes, the bottom section shall have cast openings of sufficient size
to receive the sewer pipe. If such openings are not provided, the bottom portion may be constructed of masonry work from the concrete base to at least 6” above the top of the largest pipe entering the manhole and Precast sections placed from the masonry to the desired top elevation.

5. All the annular space between the sewer pipe and the opening in the manhole section shall be filled with brick and/or masonry to provide a waterproof seal.

6. Place the manhole casting on a minimum of 3 courses of masonry brick and a maximum of 5 courses of manhole brick. Install bricks radially. Precast concrete adjusting rings may be used in place of brick.

7. Mortar joints have to be smooth tooled joints.

F. Catch basins and inlets

1. Construct catch basins and inlets as indicated on the Drawings and Specifications.

2. Place catch basin and inlet castings on a minimum of 3 courses of manhole brick and a maximum of 5 courses of manhole brick. Install brick radially. Precast concrete adjusting rings may be used in place of brick.

G. Trench bracing: Install trench bracing in accordance with safety and other pertinent rules and regulations, and Division 31 Section “Earth Moving.”

H. Erosion control and sedimentation: Contractor to provide erosion control to minimize introduction of sedimentation into the system.

3.4 CLEANING

A. Prior to acceptance of storm sewers, underdrains, manholes and drainage structures, thoroughly clean those structures and remove all dirt and debris of whatever nature from inside sewer pipes, manholes and the like, and leave the site in a neat and clean condition.

END OF SECTION 334100