



WAYNE STATE UNIVERSITY

Gateway Theater Complex

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Project Manual

Volume 1 of 4

Divisions 00 thru 14
Structural & Architectural

100% Design Development
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HGA

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SECTION 014339 MOCKUPS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: General requirements for mockups specified in other technical Sections.

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.
- B. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.

1.3 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. 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 7 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 7 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.
 - 7. Demolish and remove mockups when directed unless otherwise indicated.
- B. 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.
- C. Approved Mockups:
 - 1. Maintain approved in-place mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - a. Approved mock-up assemblies built in-place may remain as part of final Work.
 - 2. Maintain approved stand-alone mockup; do not disassemble or dispose of until so directed by Architect.
 - a. Demolish and remove stand-alone mockups when directed, unless otherwise indicated.
- D. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

1. Approved mock-up assemblies built in-place may remain as part of final Work.
2. Demolish and remove mock-ups when directed, unless otherwise indicated.
3. Mock-up shall remain on site and shall not be removed, disassembled, or disposed of until so directed by Architect.

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. Components to Include:
 - 1.

3.2 SPECIFIC MOCKUPS

- A.

3.3 OTHER MOCKUPS

- A. In addition to previous items, construct field (project site) mock-ups and samples for review where indicated in individual Specifications Sections.

3.4 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 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 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.
 - 4. Testing and Inspecting.
 - 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 017132 - Vibration Monitoring: Vibration and seismic monitoring during construction phase.
 - 2. Section 033000 - Cast-in-Place Concrete: Isolated concrete deck and isolation pads and coordination of underlayment installation.
 - 3. Section 054000 - Cold-Formed Metal Framing, Section 092216 - Non-Structural Metal Framing and Section 092900 - Gypsum Board: Stud-framed gypsum board assemblies incorporating resilient hangers and isolators.
 - 4. Section 057000 - Ornamental Metal: Metal panels and screens within performance space.
 - 5. Section 064000 - Architectural Woodwork: Wood fabrications within performance spaces.
 - 6. Section 077233 - Roof Hatches: STC-rated roof hatches.
 - 7. Section 077236 - Smoke Vents: STC-rated smoke vents.
 - 8. Section 078443 - Fire-Resistant Joint Systems: Fire-rated acoustical sealant.
 - 9. Section 083100 - Access Panels: STC-rated access panels.
 - 10. Section 083473 - Sound Control Door Assemblies.
 - 11. Section 085673 - Sound Control Window Units.
 - 12. Section 087100 - Door Hardware: Sound gasketing.
 - 13. Section 088000 - Glazing: STC-rated glass units.
 - 14. Section 092900 - Gypsum Board: Acoustic sealant, acoustic insulation, STC-rated partitions.
 - 15. Section 095100 - Acoustic Ceiling Tile.
 - 16. Section 095443 - Stretch-Membrane System.
 - 17. Section 098333 - Acoustic Plaster System.
 - 18. Section 098400 - Acoustic Surface Treatments: Sound-absorbing, [reflecting] [and] [diffusing] panels, assemblies and surface treatments for walls and ceilings.
 - 19. Section 134833 - Sound and Vibration Control: Manufactured sound and vibration control products [installation of isolated concrete slabs (floors)] [installation of spring-isolated ceilings]
 - 20. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment
 - 21. 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. Audience Chamber
 - 2. Stagehouse

3. Studio Theater
4. Sound & Light Locks
5. Trap Room
6. Control Booths
7. *Projection Booth*
8. *Dimmer Room*
9. Audio Rack Room, Sound, Communications, and AV Equipment Rooms
10. Mechanical and Electrical Rooms
11. *Café*
12. *Box Office*

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 033000 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; 2000.
- D. ACI 305R - Hot Weather Concreting; American Concrete Institute International; 1999.
- E. ACI 306R - Cold Weather Concreting; American Concrete Institute International; 1988.
- F. ACI 309R - Guide for Consolidation of Concrete; 1996.
- G. ACI 318 - Building Code Requirements for Reinforced Concrete and Commentary; American Concrete Institute International; 2005.
- H. ASTM A 185/A 185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.
- I. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2008.
- J. ASTM A 767/A 767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement; 2005.
- K. ASTM A 775/A 775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars; 2006.
- L. ASTM C 33 - Standard Specification for Concrete Aggregates; 2011.
- M. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete; 2011.
- N. ASTM C 150 - Standard Specification for Portland Cement; 2011.
- O. ASTM C 171 - Standard Specification for Sheet Materials for Curing Concrete; 2007.
- P. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a.
- Q. ASTM C 330 - Standard Specification for Lightweight Aggregates for Structural Concrete; 2009.
- R. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete; 2011.

- S. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2005.
- T. ASTM C 881/C 881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2010.
- U. ASTM C 1059/C 1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 1999.
- V. ASTM D 1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 2004.
- W. ASTM D 3963/D 3963M - Standard Specification for Fabrication and Jobsite Handling of Epoxy Coated Reinforcing Steel Bars; 2001 (2007).
- X. ASTM E 1155 - Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers; 1996 (2008).
- Y. ASTM E 1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2009.
- Z. COE CRD-C 513 - COE Specifications for Rubber Waterstops; Corps of Engineers; 1974.
- AA. COE CRD-C 572 - COE Specifications for Polyvinylchloride Waterstop; Corps of Engineers; 1974.
- AB. CRSI Manual of Standard Practice; Concrete Reinforcing Steel Institute (CRSI); 2002.

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.
 2. Architect.
 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. Stiff broom finish for Pool Deck.
- 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.
- B. Welded Wire Fabric: ASTM A 185, welded steel wire fabric supplied in flat sheets.
- 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.
- C. Lightweight Aggregate: ASTM C 330.
- 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 thycyanates 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.
 - 2. Polyvinyl Chloride Waterstops: Corps of Engineers CRD-C 572.
 - 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; Sealtight 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 100 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, rewettable 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.
 - 1. Do not allow excess form-coating material to accumulate in forms or to come in contact with in-place concrete surfaces against which fresh concrete will be placed.
 - 2. Apply in compliance with manufacturer's instructions

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.
 - 3. Report all spills to Contractor. Remove spills immediately.
 - 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.
 - 1. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound.
 - 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. Contractor 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

SECTION 033544 POLISHED CONCRETE FINISH

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Ground and polished finish applied to interior concrete slabs as exposed floor finish (CONC FIN-13).
- B. Related Sections:
 - 1. Section 033000 - Cast-In-Place Concrete: For concrete materials, mix design, placement, initial finishing and curing; and for other concrete finishes.

1.2 REFERENCES

- A. Concrete Polishing Association of America (CPAA): CPAA Recommendations for the Design, Specification and Placement of Concrete Floor Slabs for Polished Concrete
- B. National Floor Safety Institute (NFSI): NFSI Test Method 101-A Standard for Evaluating High-Traction Flooring Materials, Coatings, and Finishes.

1.3 PRE-INSTALLATION MEETING

- A. Pre-Installation Conference: Conduct conference at project site prior to installation of concrete slab to ensure complete understanding of Architect's design intent. Comply with requirements in Section 013100 - Project Management and Coordination.
 - 1. Attendees: General Contractor, Structural Engineer, Architect, Owner, concrete contractor, polishing contractor, ready-mix supplier, testing agency representative, decorative concrete product manufacturer's representatives.
 - 2. Suggested Agenda Items:
 - a. Substrate preparation requirements.
 - b. Polishing Schedule: Submit plan showing polished concrete surfaces and schedule of polishing operations for each area of polished concrete before start of polishing operations. Include locations of all joints, including construction joints.
 - c. Concrete slab mix, aggregates, cement, admixtures, reinforcement, curing agents/processes.
 - d. Review cold- and hot-weather concreting procedures, curing procedures, construction joints, concrete repair procedures, concrete finishing, and protection of concrete.
 - e. Review Contract Documents.
 - f. Subgrade: Coordinate preparation of subgrade required to be flat and level to ensure consistent concrete slab thickness.
 - g. Establish expectations for the surface appearance.
 - h. Protection: Confirm that the General Contractor, through coordination with other trades, will be responsible for the protection of the slab during construction to ensure that no contaminants such as (but not limited to) oil, grease, paint, adhesives, flux that will be present at the time of concrete polishing.
 - i. Flatness and Levelness Requirements
 - 1) Set a remedy for out of tolerance work if, Floor Flatness (F_F) and Floor Levelness (F_L) numbers do not meet specification/tolerances.
 - j. Required Slip-Resistance
 - k. Reflectivity/Gloss

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Mix Design: For concrete slab to receive polished finish. Coordinate with Section 033000.

- C. Samples for Initial Selection: Submit 4 samples, each 12-inches by 12-inches, demonstrating range of concrete mixes and colors, aggregate exposure and polished sheen.
- D. Samples for Verification: Submit 4 samples, each 12-inches by 12-inches, demonstrating range of concrete mixes and colors, aggregate exposure and polished sheen.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualifications Data: For Applicator, Product manufacturers, and Ready-Mix Supplier

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Manual: Submit installer's maintenance manual, including maintenance and cleaning instructions for polished concrete floor system.

1.7 QUALITY ASSURANCE

- A. Applicator Qualifications: Certified by concrete finish equipment and chemical manufacturer and capable of providing skilled workers who are thoroughly trained and experienced in the necessary craft.
 - 1. Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
 - 2. Installer trained by manufacturer and holding current certification for installation.
- B. Product Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction and approving application method.
- C. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.
- D. Field Sample Panels: After approval of verification sample and before casting concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, approximately 48 by 48 inches minimum, to demonstrate the expected range of finish, color, and appearance variations.
 - 1. Locate panels as indicated or, if not indicated, as directed by Architect.
 - 2. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Demolish and remove field sample panels when directed.
- E. Mockups: Prior to start of permanent installation, mockup polished concrete CON FIN-14 using same products and processes to be used in final Work. Utilize same personnel as will perform permanent Work,
 - 1. Location: Apply polished concrete finish at slab below walk-in cooler location.
 - 2. Coordinate with other Division 03 Work to install stand-alone mock-ups to verify selections made under sample submittal and to demonstrate methods and workmanship proposed for the project.
 - 3. Concrete slab must cure for a minimum of 28 days prior to start of mockup.
 - 4. Minimum Mockup Size: 100 sq. ft..
 - 5. Mockup lighting conditions under which permanent Work will be viewed.
 - 6. Demonstrate the proposed range of material characteristics and quality of application, including the following:
 - a. Matching of approved samples.
 - b. Uniformity and degree of aggregate exposure.
 - c. Uniformity and level of sheen.
 - d. Uniformity and saturation of coloring products.
 - 7. Notify Architect seven days in advance of dates and times when mockups will be constructed. Architect to be present for polishing and coloring procedure.
 - 8. 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.
 - b. Contractor to notify installer 7 days prior to pour to schedule finish of mock-up.

9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer labels indicating brand name and directions for storage, mixing with other components and application.
- B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions and keep materials from freezing.
- C. Handling: Protect materials during handling and application to prevent contamination or damage.

1.9 FIELD CONDITIONS

- A. Environmental Limitations:
 1. Concrete must be cured a minimum of 28 days or as directed by the manufacturer before application of finish can begin.
 2. Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation and other conditions affecting installation performance.
- B. Substrate Condition and Protection: Protect areas to receive polished concrete finish at all times during construction; prior to, during, and after polishing procedures. Prevent oils, dirt, metal, excessive water and other potentially damaging materials from affecting the finished concrete surface.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. Compatibility: Provide products that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer of chemicals based on testing and field experience.
- B. Source Limitations: System must consist of components produced by a single manufacturer, or as recommended by stain manufacturer, and as approved by the Architect.
 1. Provide materials that are consistent from the same lot and batch for the entire project.
 2. Concrete must be delivered from the same batch plant throughout the entire job.
 3. Calcium chloride additives should not be used with colored concrete.
- C. Products and Manufacturers: Subject to compliance with specified requirements, provide Basis of Design system or approved equivalent products comprising a system by a single source.
 1. Advanced Floor Products.
 2. The Bomanite Company.
 3. H&C Decorative Concrete Products (Subsidiary of Sherwin-Williams).
 4. L & M Construction Chemicals (Division of Laticrete).
 5. L.M. Scofield Company.
- D. (CONC FIN-13) Polished Concrete Finishing System: Complete system including surface strippers and primers, densifier and hardener, stain repellent and sealer.
 1. Coordinate with Section 033000 - Cast-In-Place Concrete for integral color pigment.
 2. Basis of Design System: RetroPlate Concrete Polishing System by Advanced Floor Products, Inc..
 - a. Contact: Brian Boie, ICS Midwest, 612.805.6293
 3. Densifier: Odorless, 0 VOC sodium-based concrete densifier, permanent sealing, densifying, and hardening compound for concrete.
 - a. Product: RetroPlate 99.

4. Stain Repellant and Sealer: Water-based penetrating stain repellent and sealer as recommended in writing by system Manufacturer.

2.2 AUXILLIARY MATERIALS

- A. Joint Filler: Rapid setting, 100% solids, flexible, two-part polyurea joint filler.
 1. Product: CreteFill Pro 75 Polyurea Joint Filler by Curecrete Distribution, Inc.; or approved equal.
 2. Color: Manufacturer's standard gray, or as determined by architect.
 3. Performance Criteria:
 - a. Tensile Strength: ASTM D412 - 740psi
 - b. Shore "A" Hardness: ASTM D2240 - 75-77
 - c. Elongation: ASTM D412 - 290%

PART 3 - EXECUTION

3.1 EXAMINATION

- A. With Applicator present, examine concrete slab for compliance with requirements, installation tolerances and other conditions affecting performance.
 1. Notify Architect of conditions that would adversely affect installation or subsequent use.
 2. Repair or otherwise correct unsatisfactory conditions.
 3. Proceed with polishing procedures only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.
- B. Slab Requirements: Verify that slabs receiving polished concrete floor finish are in compliance with requirements of Section 033000 - Cast-In-Place-Concrete, in accordance with written recommendations and agreements resulting from pre-installation conference; and as follows:
 1. Minimum Compressive Strength: 4,000 psi at 28 day strength.
 2. Curing Method: Minimum 8 day water cured or dissipating curing compound applied.
 3. Slab Finish: Bull-floated, smooth, pan-finished (smooth power-troweled) floor from edge to edge, with no rough areas.
 4. Flatness and Levelness: Tested within 8 hours after completion of the final troweling operation according to ASTM E1155 *Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers*:

	Specified Overall Value	Minimum Local Value
FF Floor Flatness	45	35
FL Floor Levelness	30	20

3.2 PREPARATION

- A. Slab Repair: Employ same repair methods as demonstrated on mockup and approved by Architect.
 1. Mix patching compound or grout material with dust created by grinding operations, manufacturer's tint, or sand to match color of adjacent concrete surfaces.
 2. Fill surface imperfections including, but not limited to, holes, surface damage, small and micro cracks, air holes, pop-outs, and voids with grout to eliminate micro pitting in finished work.
 3. Work compound and treatment until color differences between concrete surface and filled surface imperfections are not reasonably noticeable when viewed from 10 feet away under lighting conditions that will be present after construction.
- B. Cleaning: Remove dirt, dust, rust, debris, oil, grease, curing agents, bond breakers, paint, coatings, and other surface contaminants which could adversely affect installation of polished concrete floor system.
 1. Remove dirt, stains, measurement markings, oversprayed materials, tread marks and footprints that would remain visible in final Work.

2. Verify that floor and joints are dry and free of debris and excessive dirt, dust, clay, sand and gravel
- C. Adjacent Surfaces: Protect adjacent surfaces as required to prevent damage by the concrete polishing procedure.

3.3 APPLICATION, GENERAL

- A. Apply polished concrete finish system to accepted and approved slab surfaces using methods required to match approved Mockup.
- B. Control and dispose of waste products produced by grinding and polishing operations.
- C. Dye: Apply penetrating dye for polished concrete in polishing sequence and according to manufacturer's written instructions.
- D. Densifier: Apply penetrating densifier and hardener in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
- E. Other Treatments: Apply sealer, stain protection, or other final treatments, if applicable.
- F. Neutralize and clean polished floor surfaces.

3.4 GRINDING

- A. Aggregate Exposure: Machine grind floor surfaces level, smooth and to depth required to reveal aggregate in accordance with CPAA class specified, and as selected by Architect to match approved mockup.
 1. Class B, Fine Aggregate (Salt-and-Pepper): Remove not more than 1/16 inch of concrete surface by grinding and polishing resulting in majority of exposure displaying fine aggregate with no, or small amount of, medium aggregate at random locations.
 - a. Approximate average size of exposed aggregate: 1/16-inch.

3.5 POLISHING

- A. Finished Gloss Level: In accordance with CPAA, and as selected by Architect to match approved mockup.
 1. Level 3: High-Gloss, Semi-Polished Appearance.
 - a. Reflective Clarity: 65.
 - b. Reflective Sheen: 35.
 2. Level 4: Very-High-Gloss, Highly-Polished Appearance.
 - a. Reflective Clarity: 85.
 - b. Reflective Sheen: 50.
- B. Measurement: Test surfaces prior to application of sealers.
 1. Reflective Clarity (Distinctness-Of-Image): ASTM D5767 - Standard Test Methods for Instrumental Measurement of Distinctness-of-Image Gloss of Coating Surfaces; when viewed 5 feet above and perpendicular to a surface, the degree of sharpness and crispness of the reflection of the overhead objects.
 2. Reflective Sheen: ASTM D523 Standard Test Method for Specular Gloss; when viewed at 20 feet from and at an angle to a surface, the degree of gloss reflected from the surface.

3.6 JOINT TREATMENT

- A. Fill construction joints and cracks with filler products as specified in accordance with manufacturer's instructions colored to match with concrete color as specified by architect.

3.7 FIELD QUALITY CONTROL

- A. Inspect completed polished concrete floor system with Owner, Contractor, Architect, and Installer.
- B. Slip Resistance: Achieve following coefficient of friction by field quality control when tested in compliance with ASTM C1028:

1. ANSI B101.1 Static Coefficient of Friction: Minimum of 0.50 for level floor surfaces.
- C. Review procedures with Architect to correct unacceptable areas of completed polished concrete floor system.

3.8 INSTALLED WORK

- A. Repair: Repair damaged areas of completed polished concrete floor system to satisfaction of Architect.
- B. Clean: Immediately remove mortar splatter, spilled liquids, oil, grease, paint, coatings, and other surface contaminants which could adversely affect completed polished concrete floor system.
- C. Protection: Protect finished Work during remainder of construction.

END OF SECTION

SECTION 034500 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.
- 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
- E. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel"; and AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- 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. <Insert Regional Fabricators>
 - 2. American Artstone.
 - 3. Gage Brothers Concrete Products, Inc..
 - 4. Hanson Structural Precast Midwest, Inc., Maple Grove, MN.
 - 5. IPC, Inc., Iowa Falls, IA.
 - 6. Wells Concrete Products Co., Wells, MN.
- B. (APC-1) Architectural Precast Concrete Units: Surface finish and dark integral color matching Architect's sample.
 - 1. Basis of Design: 13-11 MAE (Acid Etched) with dark aggregate by American Artstone.

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.
 - a. Gradation: To match design reference sample.
 - 2. Fine Aggregates: Selected, natural or manufactured sand of the same material as coarse aggregate, unless otherwise approved by Architect.
 - a. Provide aggregates that are acceptable for acid wash finish, without discoloring or dissolving.
- C. Coloring Admixture: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures, temperature stable, nonfading, and alkali resistant.

- D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.

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. (APCA-1) 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:
 - 1. Compressive Strength (28 Days): 6000 psi.
 - 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.
- E. Reinforcement: Comply with recommendations in CRSI's "Manual of Standard Practice" and PCI MNL 117 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.
 - 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 042000 UNIT MASONRY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Clay face brick (FBR).
2. Mortar and Masonry Grout:
 - a. Testing of mortar and masonry grout.
 - b. Admixtures for mortar and masonry grout.
3. Reinforcement and Anchoring Materials:
 - a. Steel reinforcement bars.
 - b. Masonry-joint reinforcement.
 - c. Brick ties and anchors (BT).
4. Drainage:
 - a. Through-wall flashing (TWF)
 - b. Weep systems (WPS).
5. Miscellaneous masonry accessories (MA).

B. Related Requirements:

1. Section 014533 - Structural Testing and Special Inspections.
2. 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.
3. Section 051200 - Structural Steel Framing items to be built into masonry work.
4. Section 055000 - Metal Fabrications: Steel lintels, shelf angles, installation of metal fabrications including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
5. Section 076200 - Sheet Metal Flashing and Trim: Reglets to be built in masonry work.
6. Section 079000 - Joint Protection: Sealants for expansion and contraction joints.

1.2 ACTION SUBMITTALS

A. Product Data: Product data for each type of masonry unit and accessory, including manufacturer's installation recommendations.

B. Shop Drawings:

1. Masonry Units: Show sizes, profiles, coursing, locations of special shapes.
 - a. Include building elevations showing layout of units and locations of joints and anchors.
2. Show locations, types and quantities of bolsters, spacers, chairs, support bars and other accessories.
3. Expansion joint layout for masonry veneer.
4. Mockup shop drawings.

C. Samples:

1. Face Brick: Submit samples demonstrating each color and blended color range.
2. Mortar Samples: For each color of mortar required. Label Samples to indicate types and amounts of pigments used. Make Samples using same sand and mortar ingredients to be used on Project.
3. Sanded Sealant Joint Samples: Coordinate with Section 079000 - Joint Sealants for sanded sealant joints required to match mortar joints.
4. Masonry Accessories: Submit samples of each type of embedded accessory.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

- B. Material Certificates: For each type and size of the following:
1. Masonry Units:
 - a. Include data on material properties and material test reports substantiating compliance with requirements.
 - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include test report for efflorescence according to ASTM C 67.
 - d. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 2. Cementitious materials. Include name of manufacturer, brand name, and type.
 3. Mortar admixtures.
 4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 5. Grout mixes. Include description of type and proportions of ingredients.
 6. Reinforcement bars.
 7. Joint reinforcement.
 8. Anchors, ties, and metal accessories.
- C. Mix Designs and Preconstruction Test Data: Include description of type and proportions of ingredients and state building components in which each will be used.
1. Mortar: Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109 for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
 2. Grout: Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
 - a. Use proportion specification of ASTM C476 as a minimum criterion and design for minimum compressive strength of 3,000psi when tested in accordance with ASTM C1019.
 3. Masonry Unit Statement of Compressive Strength: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.

1.4 QUALITY ASSURANCE

- A. Pre-Installation Conference: Conduct conference at Project site to comply with requirements in Section 013100 - Project Management and Coordination.
- B. Installer Qualifications: Engage an experienced masonry installer to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance.
- C. Sample Panel Mockups: Build sample panel for each type of exposed unit masonry, approximately 48 inches long by 96 inches high, to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution. Include the following in sample panel:
1. Mortar joints representing each mortar color.
 2. Obtain Architect's acceptance of sample panels for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
- D. Integrated Mockup: Prior to installation of unit masonry work, coordinate with Work of other Sections and construct integrated mockup in accordance with Section 014339 - Mockups, using materials and methods required for final Work, to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Mockup Pre-Installation Conference: Before beginning mock-up construction and installation, conduct pre-installation conference with, installer, Architect, Owner and other interested parties to review procedures, schedules, and coordination of curtain wall installation with other elements of Work.
 2. Build mockups of typical exterior wall area, including the following:

- a. Facebrick.
 - b. Trim units.
 - c. Mortar joints, demonstrating each type of mortar color.
 - d. Sanded sealant joints.
 - e. Window opening with moisture barrier terminations shown.
 - f. Back-up wall, including metal studs, sheathing, veneer anchors, flashing, and weep holes in veneer wall mockup.
3. Obtain Architect's acceptance of visual qualities of mock-up before start of masonry work. Provide separate mock-up panel for each type of exposed unit masonry work.
- a. Approval of mockups is for color, texture, and blending of face brick; relationship of mortar and sealant colors to brick colors; tooling of joints; and aesthetic qualities of workmanship.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - c. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
 - 1) Protect accepted mockups from the elements with weather-resistant membrane.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. Storage:
1. 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.
 2. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
 3. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
 4. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.6 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. Maintain protective boards at exposed external corners which may be damaged by construction activities. Provide such protection without damaging completed work.
 3. Provide temporary bracing during erection of concrete block work. Maintain in place until building structure provides permanent bracing.
 4. 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.
 5. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - a. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - b. Protect sills, ledges, and projections from mortar droppings.
 - c. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - d. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

- 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.
- C. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
- D. Keep cavities and joints clear of mortar and trash.

PART 2 PRODUCTS

2.1 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. Appearance Requirements of Exposed Masonry: Provide masonry units of uniform color and texture matching the range represented by Architect's sample.
 - 1. Architect reserves the right to reject unit masonry manufacturer if, in Architect's opinion, unit quality, color or texture is unacceptable with design intent.
 - 2. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample for color, finish, and other aesthetic characteristics, as determined by the Architect.
 - a. Architect's decision is final on whether or not a proposed product matches.
 - 3. Appearance requirements may be waived by Architect for concealed units.
- D. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.
- E. 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 FACE BRICK UNITS

- A. (FBR) Face Brick: ASTM C216, Grade SW, Type FBS
 - 1. Basis of Design: Interstate Brick.
- B. Schedule:
 - 1. FBR-1: Lighter, limestone color
 - 2. FBR-2: Darker, gray color, ironspot
 - 3. FBR-3: Same blend as FBR-1, special unit size
 - 4. Bond: As shown..
- C. Special Shapes: Provide shapes indicated on Drawings and for special applications , including; where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels; where shapes produced by sawing would result in sawed surfaces being exposed to view. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.

2.3 LINTELS

- A. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 - Cast-in-Place Concrete, and with reinforcing bars indicated.
- B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
- C. Built-Up Structural Steel Lintel: Refer to Section 051200 - Structural Steel Framing.
- D. Loose Steel Lintels: Refer to Section 055000 - Metal Fabrications.

2.4 MORTAR 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. Provide natural color or white cement as required to produce mortar color indicated.
 - 2. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
 - 3. non-staining
 - 4. without air-entrainment.
 - 5. 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: Not allowed.
- F. Colored Cement Mortar Products: Packaged, pre-mixed blend made from portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.
 - 1. Color: As selected from manufacturer's full color range.
 - 2. Formulate blend as required to produce color indicated.
 - 3. Pigments shall not exceed 10 percent of portland cement by weight.
- 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.
 - 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 - 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- H. Water: Potable.

2.5 REINFORCEMENT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Heckman Building Products.
 - 2. Hohmann and Barnard Incorporated.
 - 3. AA Wire Products Co.
- B. Uncoated-Steel Reinforcement Bars: ASTM A 615 or ASTM A 996, Grade 60.
- C. Epoxy Coated Reinforcement 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 Reinforcement 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.
- D. 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.
- E. Wire Bar Type Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place; manufactured according to CRSI's "Manual of Standard Practice".
- F. Horizontal Masonry-Joint Reinforcement: ASTM A 951.
1. Interior Walls: Mill- or Hot-dip galvanized carbon steel.
 2. Exterior Walls: Hot-dip galvanized carbon steel.
 3. Wire Size for Side Rods and Cross Rods: 0.148-inch diameter, minimum.
 4. Wire Size for Veneer Ties: 0.187-inch diameter, minimum.
 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
 7. (HZRE-1) Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods. Continuous wire joint reinforcing with 9 gauge side rods and crossrods. Use prefabricated corners and tees at wall intersections.
 - a. Exterior: Hot dipped galvanized wire ASTM A 153, Class B-2 (1.5 oz. PSF).
 - b. Interior: Mill galvanized wire ASTM A641. Class 1 (0.40 minimum zinc coating).

2.6 ANCHORS AND FASTENERS

- A. Materials:
1. Stainless-Steel Wire: ASTM A 580, Type 304.
 2. Stainless-Steel Sheet: ASTM A 240, Type 304.
- B. Size: Sufficient to extend at least halfway, but not less than 1-1/2 inches, through stone masonry and with at least 5/8-inch cover on outside face.
- C. Wire Veneer Anchors: Wire ties formed from W1.7 or 0.148-inch-diameter, stainless-steel wire.
- D. Stainless-Steel Drill Screws for Steel Stud Backup: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 by length required to penetrate steel stud flange with not less than three exposed threads.
- E. Stainless Steel Tapping Screws for CMU Backup: Self-tapping screws with specially designed threads for anchoring into masonry and concrete, with hex washer head 1/4-inch diameter by as required to embed 1-1/2-inch into substrate material.
- F. Adjustable, Screw-Attached Veneer Anchors: Units consisting of a wire tie section and a metal anchor section that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over concrete sheathing to metal studs, and as follows:
1. Manufacturers and Products:
 - a. Hohmann & Barnard, Inc.; X-Seal Anchor or similar product approved by Architect.
 - b. Wire-Bond.
- G. (BT-1) Brick Veneer Anchors and Ties: Stainless steel.
1. Anchors for Concrete Backup Wall: 2-Seal Thermal Concrete Wing Nut Anchor by Hohmann & Barnard, Inc..
 2. Anchor for Steel Stud Backup Wall: 2-Seal Thermal Wing Nut Anchor by Hohmann & Barnard, Inc..
 3. Tie for Concrete Backup Wall: Thermal Concrete 2-Seal Tie by Hohmann & Barnard, Inc..
 4. Tie for Steel Stud Backup Wall: Thermal 2-Seal Tie by Hohmann & Barnard, Inc..

2.7 FLASHING AND WEEP SYSTEMS

- A. (TWF-1) Through-Wall Flexible Membrane Flashing: Self-adhering elastomeric thermoplastic composite flashing product, 40 mil thick, consisting of a polyester-reinforced ethylene interpolymer alloy, and with pressure sensitive clear adhesive. Provide type that is compatible with MB as specified in Section 072700 - Air & Moisture Barrier.
1. Products and Manufacturers:
 - a. Thru-Wall Flashing by DuPont
 - b. Flex-Flash by Hohmann & Barnard, Inc..
 - c. Hyload Cloaked Flashing System by Hyload, Inc...
 2. Termination Bars: Stainless steel bar predrilled at 8 inches on center
 - a. Size: 1/8 inch thick by 1-1/2 inches high by 8 feet long
 - b. Fasteners: Stainless steel
 - c. Product and Manufacturer: D/A 1510 by Dur-O-Wal
 3. Factory-formed extruded drip edge, 45 mils: Flex-Flash Drip Edge by Hohmann and Barnard, Inc..
 4. Adhesives and Primers for Flashings: Flashing manufacturer's standard products or products recommended by the flashing manufacturer for bonding flashing sheets to each other and to substrates.
 5. Sealant: Flashing manufacturer's standard products or products recommended by the flashing manufacturer to seal seam edges and terminations.
- B. (WPS-1) Rope Wick Weep System: Cavity drainage fabric with cotton rope wicks at head joints for use in cavity wall construction.
1. Cavity Drainage Fabric: Non-woven polyethylene mesh, 2 inch thick (more than one layer may be needed to achieve 2 inch depth), to prevent mortar droppings from blocking weep holes.
 - a. Acceptable Product and Manufacturer: Mortar Net by Mortar Net Incorporated.
 2. Rope Wicks: 100 percent cotton fiber stranded rope, 3/8 inch diameter, 24 inches long
- C. (WPS-2) Cellular Plastic Weep/Vent: One-piece, extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of masonry unit, in color selected from manufacturer's complete range.
1. Manufacturers and Products:
 - a. Advanced Building Products Inc.; Mortar Maze weep vent.
 - b. Blok-Lok Limited; Cell-Vent.
 - c. Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
 - d. Heckmann Building Products Inc.; No. 85 Cell Vent.
 - e. Hohmann & Barnard, Inc.; Quadro-Vent.
 - f. Wire-Bond; Cell Vent.
- D. (WPS-3) Mesh Cavity Drainage: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Manufacturers and Products:
 - a. Advanced Building Products Inc.; Mortar Break.
 - b. CavClear/Archovations, Inc.; CavClear Masonry Mat.
 - c. Dur-O-Wal, a Dayton Superior Company; Polytite MortarStop.
 - d. Mortar Net USA, Ltd.; Mortar Net.

2.8 MASONRY ACCESSORIES

- A. (MA-1) Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
1. Product and Manufacturer: RS Series Rubber Control Joints by Hohmann and Barnard, Inc..
- B. (MA-2) Deflection Material: Pre-molded compressible filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.
1. Product and Manufacturer: NS Closed Cell Neoprene Sponge by Hohmann and Barnard, Inc..

- C. (MA-3) Column Wrap: Open cell polyurethane foam, 1/4 inch thick.
- D. (MA-4) Control Joint Bond Breaker:
 - 1. Type: 6 mil thick polyethylene film.
 - 2. Type: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- E. Masonry Cleaner: Use masonry cleaner to clean all exposed masonry work. Type of cleaner as recommended by manufacturer for each type of masonry material.
 - 1. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
 - a. Basis of Design: Sure Klean masonry cleaner by PROSOCO Incorporated.
 - b. Other Acceptable Manufacturers:
 - 1) American Building Restoration Products, Inc., Franklin, WI.
 - 2) L&M Chemicals,
 - 3) Diedrich Technologies, Inc., Oak Creek, WI.
- F. Clay Face Brick Sealer: Silane/Siloxane-Blend, Penetrating Water Repellent: Clear, silane and siloxane blend with 400 g/L or less of VOCs.
 - 1. Low odor and alkaline stable.
 - 2. Basis of Design: Sure Klean Weather Seal Siloxane PD by Prosoco Inc..

2.9 MORTAR 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.
 - 7. Colored Mortar:
 - a. Pigments shall not exceed 10 percent of portland cement by weight.
 - b. Mix to match Architect's sample.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar Mixes:
 - 1. Mortar for Non-Load Bearing Unit Masonry: ASTM C270, type as scheduled using Proportion or Property specification.
 - 2. Mortar for Loadbearing Unit Masonry (indicated on structural drawings): ASTM C270, type as scheduled using Property specification.
- D. 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. Exterior, above-grade, face brick veneer, non-load-bearing walls: Type S.

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. Examine rough-in and built-in construction for piping systems to verify actual locations of piping connections. Verify that items built-in by other trades are properly located and sized.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 MIXING MORTAR

- 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 with 2 1/2 hours after initial mixing.

3.3 INSTALLATION, GENERAL

- A. Layout: 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. 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.
 - 3. Place masonry in accordance with lines and levels indicated on drawings. Lay from exposed side, plumb, level and true to modular dimensions.
 - 4. 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.
 - 5. Build chases and recesses to accommodate items specified in this and other Sections.
 - 6. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- 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.
 - 1. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- C. Exposed Units: 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.
- D. 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. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
 2. Wherever bolts, brackets and similar anchor items are cast-in masonry, fill voids in masonry with mortar to adequately anchor and transmit loads.
 3. Build-in items plumb and true.
 4. Do not build-in organic materials which will be subjected to rot or deterioration.
 5. Fill in solidly with masonry around built-in items.
- E. Anchoring Masonry to Structure: Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
1. Provide an open space between masonry and structural steel or concrete as shown, unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.
- F. 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.
- B. Lines and Levels:
1. Bed Joints and Top Surfaces of Bearing Walls: Do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
 2. Conspicuous Horizontal Lines (such as lintels, sills, parapets, and reveals): Do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
 3. Vertical Lines and Surfaces: Do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
 4. Conspicuous Vertical Lines (such as external corners, door jambs, reveals, and expansion and control joints): Do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
 5. Lines and Surfaces: Do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
 6. Vertical Alignment of Exposed Head Joints: Do not vary from plumb by more than 1/4 inch in 10 feet or 1/2-inch maximum.
 7. Faces of Adjacent Exposed Masonry Units: Do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
 8. Concrete Block to Receive Direct-Applied Finishes: Lay block plumb, with flush mortar joints and with maximum surface variation of 1/8 inch in 10 feet.
- C. Joints:
1. Bed Joints: Do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
 2. Exposed Bed Joints: Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
 3. Head and Collar Joints: Do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
 4. Exposed Head Joints: Do not vary from thickness indicated by more than plus or minus 1/8 inch.

5. Exposed Head Joints and Bed Joints of Stacked Bond: Do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.5 MORTAR BEDDING AND JOINTING

- A. Laying Face Brick: Lay units with completely filled bed and head joint, except at expansion and control joints. Butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.
 1. Lay out to eliminate brick less than one-half length.
 2. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
 3. Bevel rear of bed joint at cavity to exclude mortar from protruding into cavity.
 4. Buttering corners of joints, deep or excessive furrowing of mortar joints is not permitted.
 5. Do not shift or tap masonry after mortar has taken initial set. Where adjustment must be made, remove mortar and replace.
- B. Mortar Joint Tooling for Face Brick: Provide special raked as formed by special joint tool:
 1. Basis of Design: Raked Joint Tool by Brick Tech Architectural.
 2. Tool exposed joints when thumbprint hard, using a jointer larger than joint.
 3. Rake out mortar in preparation for application of sealants, where required.
- C. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

3.6 ANCHORED MASONRY VENEERS

- A. Anchoring At Backup Wall: Anchor masonry veneers to back-up wall with masonry-veneer anchors to comply with the following requirements:
 1. Fasten anchors to backup wall with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 2. Embed ties and continuous wire in masonry joints.
 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 4. Provide seismic anchors, as applicable.
- B. Anchor Spacing at Metal Stud Backup Wall: Space anchors as indicated, but not more than 18 inches o.c. vertically and 24 inches o.c. horizontally, with not less than one anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.
- C. Anchor Spacing at CMU or Concrete Backup Wall: Space anchors as indicated, but not more than 16 inches o.c. vertically and 25 inches o.c. horizontally, with not less than one anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.
- D. Anchor Spacing at CMU or Concrete Backup Wall: Space anchors as indicated, but not more than 18 inches o.c. vertically and horizontally. Install additional anchors within 12 inches of openings and at intervals, not exceeding 24 inches, around perimeter.

3.7 MASONRY JOINT REINFORCEMENT

- A. Joint Reinforcement: 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. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 36 inches beyond openings in addition to continuous reinforcement.
 4. Place joint reinforcement at bed joint at top course of wall or partition, continuous full length of wall.
 5. At foundation walls with earth on both sides, provide reinforcement only at top 2 courses.
 6. Refer to Structural Drawings for locations of reinforcement bars within concrete masonry wall section.

7. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

3.8 CONTROL AND EXPANSION JOINTS

- A. Control Joints and Expansion Joints, General: Provide as indicated and where shown on Drawings, or if not shown, review locations with Architect prior to start of installation.
 1. Install control- and expansion-joint materials in unit masonry as masonry progresses.
 2. Form joints in CMU and face brick straight and true.
 3. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
 4. Unless otherwise shown on Structural Drawings, end reinforcing approximately one inch either side of joints.
- B. Expansion Joints at Face Brick:
 1. Provide control joints in brick work as indicated 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. 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.
- C. Pressure-Relieving Joints: 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.
- D. 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.

3.9 LINTELS

- A. Install steel lintels where indicated.
- B. Provide reinforced concrete block lintels over openings where indicated on drawings.
 1. Construct lintels and bond beams using concrete and reinforcing steel as specified on drawings. Erect on full even beds of mortar with reinforced grout filled jambs as indicated on the Drawings.
 2. For lintels, use reinforcement bars of full lengths only.
 3. Place and consolidate grout without disturbing reinforcing. Construct lintels on plank, adequately supported, joints equally spaced. Do not support lintels with hollow metal door frames. Fill spaces around built-in items solid with masonry and mortar unless otherwise indicated. Clean out spaces prior to pouring grout.
 4. Allow lintel to reach 90 percent design strength or 28 days before removing temporary supports. Remove units that show evidence of cracking.
 5. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.10 FLASHING, WEEP HOLES, AND CAVITY VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
- B. Flashing Installation:
 1. Install flashing as brick is laid and protect from damage. Lap ends and seal, with laps in direction of moisture flow.
 - a. Adhesive apply and anchor flashing in place to prevent moisture from penetrating behind or under flashing.

- b. At flashing horizontal terminations, construct end dams one brick course in height with joints lapped and sealed.
 - 2. Attach flashing with termination bar to backup wall. Apply continuous bead of sealant along top of termination bar.
 - 3. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
 - 4. Form end dams with ends turned up minimum of 2-1/2 inches. Seal edges of end dam.
 - 5. Form inside and outside corners with additional piece of membrane. Comply with manufacturer's instructions on corner construction.
 - 6. Seal joints in flashing system with butyl rubber sealant.
 - 7. Repair membrane where bird mouths and improper installation creates openings in the membrane: Cut bird mouths and patch with membrane minimum of 6 inches each direction from cut and seal edges with sealant.
 - 8. Coordinate installation of through-wall flashing with installation of (MB-1) specified in Section 072700 - Air & Moisture Barriers.
 - 9. Place through wall flashings in accordance with manufacturer's recommendations.
 - 10. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape.
 - 11. (TWF-1) Flexible Flashing: Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
 - a. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
 - b. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
 - 12. Provide weep holes in head joints of first course of veneer masonry immediately above embedded flashing.
- C. (WPS-1) Rope Wicks: Install at 16 inches on center and extend other end up inside of back-up wall.
- 1. Install at head joint location, at bottom of cavity walls, and at lintels and relieving angles. Secure at 45 degree angle to back-up.
 - 2. Tie rope wicks to first row of masonry ties.
 - 3. Install cavity drainage fabric according to manufacturer instructions.
 - 4. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 - 5. Trim wicking material flush with outside face of wall after mortar has set.

3.11 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage qualified special inspectors in accordance with Section 014533. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.
 - 1. Quality Assurance: Level **[B]** **[C]** in TMS 402/ACI 530/ASCE 5.
 - 2. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 - 3. Place grout only after inspectors has verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 - 4. Place grout only after inspectors have verified proportions of site-prepared grout.
- B. Testing Method:
 - 1. Unit Strength Method:
 - a. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.
 - b. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
 - c. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

- d. Mortar Test (Property Specification): Perform tests of mortar and mortar materials for each mix provided, according to ASTM C 780.
 - 1) Compressive Strength: ASTM C 109
 - 2) Water Retention: ASTM C 1506
 - 3) Air Content: ASTM C91
 - e. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.
 - 2. Prism Test: For each type of construction provided, according to ASTM C 1314 at [7 days and at]28 days.
- C. Testing Frequency:
- 1. Preconstruction Testing: One set of tests.
 - 2. During Construction: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

3.12 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 as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
 - 6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
 - 7. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
 - 8. Clean stone trim to comply with stone supplier's written instructions.
 - 9. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.13 INSTALLED WORK

- 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 042200 CONCRETE UNIT MASONRY

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. Brick veneer unit masonry.
- B. Concrete unit masonry.
- C. Decorative concrete unit masonry.
- D. Reinforced unit masonry.
- E. Concealed embedded flashing.

1.03 RELATED SECTIONS

- A. Section 07 2129.13 - Sprayed Polyurethane Insulation.
- B. Section 07 2100 - Thermal Insulation; for rigid insulation below flashing.

1.04 PRODUCTS FURNISHED BUT NOT INSTALLED

- A. Dovetail anchor slots installed under Section 03 3000 - Cast-In-Place Concrete.

1.05 PRODUCTS INSTALLED BUT NOT FURNISHED

- A. Steel lintels and shelf angles for unit masonry are specified in Section 05 5000 - Metal Fabrications.

1.06 REFERENCES

- A. ACI 530/ASCE 5/TMS 402 - Building Code Requirements for Masonry Structures; American Concrete Institute; 2005.
- B. ACI 530.1/ASCE 6/TMS 602 - Specification For Masonry Structures; American Concrete Institute; 2005.
- C. ASTM C 67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile; 2009.
- D. ASTM C 90 - Standard Specification for Loadbearing Concrete Masonry Units; 2011b.
- E. ASTM C 91 - Standard Specification for Masonry Cement; 2005.
- F. ASTM C 140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units; 2011.

- G. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar; 2004.
- H. ASTM C 150 - Standard Specification for Portland Cement; 2011.
- I. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2006.
- J. ASTM C 216 - Standard Specification for Facing Brick (Solid Masonry Units Made From Clay or Shale); 2011.
- K. ASTM C 270 - Standard Specification for Mortar for Unit Masonry; 2010.
- L. ASTM C 404 - Standard Specification for Aggregates for Masonry Grout; 2007.
- M. ASTM C 476 - Standard Specification for Grout for Masonry; 2010.
- N. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2010.
- O. ASTM C 1019 - Standard Test Method for Sampling and Testing Grout; 2008.
- P. ASTM C 1142 - Standard Specification for Extended Life Mortar for Unit Masonry; 1995 (R2001).
- Q. ASTM C 1311 - Standard Specification for Solvent Release Sealants; 2002.
- R. ASTM C 1314 - Standard Test Method for Compressive Strength of Masonry Prisms; 2010.
- S. ASTM C 1623 - Standard Specification for Manufactured Concrete Masonry Lintels; 2006.
- T. Standard for Bracing Masonry Walls Under Construction; Council For Masonry Wall Bracing.
- U. Hot & Cold Weather Masonry Construction; Masonry Industry Council; 1999.
- V. IMIAWC (CW) - Recommended Practices & Guide Specifications for Cold Weather Masonry Construction; International Masonry Industry All-Weather Council; 1993.
- W. IMIAWC (HW) - Recommended Practices & Guide Specifications for Hot Weather Masonry Construction; International Masonry Industry All-Weather Council; current edition.
- X. NCMA TEK 3-4B - Bracing Concrete Masonry Walls During Construction; National Concrete Masonry Association; 2000.

1.07 SUBMITTALS

- A. See Section 01 3323 - Shop Drawings, Product Data, and Samples, for submittal procedures.
- B. Product Data: Provide manufacturer's product data for each different masonry unit, accessory and other manufactured product indicated.
- C. Shop Drawings: Submit shop drawings for fabrication and installation of the following: unit masonry reinforcing bars.
 - 1. Reinforcing Steel: Detail bending and Placement of masonry reinforcing bars. Comply with ACI 315 - Details and Detailing of Concrete Reinforcement.
 - 2. Fabricated Flashing: Details of corner units, end dam units, and other special applications.
- D. Samples: Submit full size samples of each different exposed brick masonry unit, all colored masonry mortar, and all accessories. Indicate full range of exposed color, texture and dimensions to be expected in completed work.
- E. Material Certificates:
 - 1. Submit material certificates for each different masonry product required signed by manufacturer and Contractor certifying each material complies with requirements.
 - 2. Fire-Rated Masonry: Submit certificates indicating compliance with equivalent thickness rating method as follows:
 - a. CMU: Chapter 3 of ACI 216.1.
 - b. Clay Masonry: Chapter 4 of ACI 216.1.
 - 3. Mix designs for mortar, standard grout and self-consolidating grout.

- F. Material Test Reports (prior to fabrication): Submit test reports from a qualified independent testing laboratory employed and paid by Contractor indicating and interpreting test results relative to compliance of mortar, grout mixes and masonry units with requirements indicated.
 - 1. Test Reports shall have been performed within 18 months of Contract date. Test Reports more than 18 months old are not acceptable.
- G. Material Test Reports After Material Fabrication for Clay Masonry: Submit test reports
 - 1. Test reports must be provided on from a qualified independent testing laboratory employed and paid by Contractor indicating and interpreting test results relative to compliance with requirements of ASTM C216 with C67
- H. Masonry Material Cleaning Plan: Include products and techniques for each masonry product and each assembly being constructed for this Project. Prior to submission, Cleaning Plan shall be signed and approved by:
 - 1. Contractor.
 - 2. Mason Contractor.
 - 3. All masonry unit manufacturers.
 - 4. Cleaning materials supplier and manufacturer.
 - 5. Cleaning Subcontractor.
- I. Weather Procedures Certification: Submit written Statement certifying construction procedures utilized for cold weather and hot weather conditions comply with requirements specified in referenced unit masonry standard.
- J. Foreman Certification: Copy of Foreman Certification for grouting reinforced masonry.

1.08 QUALITY ASSURANCE

- A. Industry Standards: Comply with recommendations of Brick Industry Association (BIA), National Concrete Masonry Association (NCMA), American Concrete Institute (ACI), and American Society of Civil Engineers (ASCE) as applicable.
- B. Foreman Certification: Masonry foreman responsible for placement of grouted reinforced masonry shall hold a current certification from Masonry Institute of Michigan (MIM) or International Masonry Institute (IMI) training program for reinforced unit masonry assemblies.
- C. Unit Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 "Specifications for Masonry Structures", except as otherwise indicated.
 - 1. Revise ACI 530.1/ASCE 6/TMS 602 to exclude Sections 1.4 and 1.7; Parts 2.1.2, 3.1.2 and 4.1.2; and Articles 1.5.1.2, 1.5.1.3, 2.1.1.1, 2.1.1.2 and 2.3.3.9, and to modify Article 2.1.1.4 by deleting requirement for installing vent pipes and conduits built into masonry.
- D. Material Test Reports on Clay Masonry products prior to delivery to site: Provide material test reports on actual clay masonry products that have been fabricated for the project. Provide tests per ASTM C216 sampled in accordance with ASTM C67. Architect will reject acceptance of brick outside of specified performance requirements. Provide a report on the following:
 - 1. Dimensional Tolerances
 - 2. Compressive Strength
 - 3. Hot Water Absorption
 - 4. Cold Water Absorption.
- E. Single-Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or uniform blend within the accepted range for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.
- F. Single-Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality from one manufacturer for each cementitious component and from one source and producer for each aggregate.

1.09 MASONRY INSPECTION

- A. Inspections: Masonry work shall be inspected per MBC Chapter 17, ACI 530.1 - 1.5, 1.6, 2.3 and ASTM C 140.
 - 1. Inspections shall be performed by a Certified Masonry Inspector employed by an independent Testing/Inspection Agency acceptable to Architect.
 - 2. The following require special inspections:
 - a. Unit layup Periodic
 - b. Reinforcing bar placement: Periodic
 - c. Grout placement: Continuous
 - d. Other components as stated in Code.

1.10 MOCK-UP

- A. Field-Constructed Mock-Ups: Prior to installation of unit masonry, erect sample wall panels to further verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mock-up to comply with the following requirements, using materials indicated for final unit of work:
 - 1. Locate mock-up on site as directed by Architect.
 - 2. Size: Approximately 8 feet long by 6 feet high.
 - 3. Typical exterior face brick wall; include face and backup wythes, and through wall flashing, as well as accessories utilizing each brick type in pattern directed by Architect.
 - 4. Typical exterior brick-veneer wall; include face brick, cold formed metal studs, sheathing, air infiltration barrier, veneer ties, flashing, weep holes, and cavity drainage material.
 - 5. Notify Architect one week in advance of the date and time when mock-up will be erected.
 - 6. Protect mock-up from the elements with weather-resistant membrane.
 - 7. Retain and maintain mock-up during construction in undisturbed condition as standard for judging completed unit masonry work.
 - a. When directed, demolish and remove mock-up from Project site.
- B. Grout Demonstration Panel: For self-consolidating grout, construct a separate "Grout Demonstration Panel". The panel shall be representative of the actual wall construction.
 - 1. Evaluation Criteria for panel shall include the following:
 - a. Compressive strength.
 - b. Bond to masonry units.
 - c. Grout consolidation.

1.11 PRE-INSTALLATION CONFERENCE

- A. Schedule a pre-installation conference at Cass Ave, Detroit MI-48201, minimum two weeks prior to start of masonry work, with the following parties in attendance.
 - 1. Owner's Representative.
 - 2. Architect.
 - 3. Contractor.
 - 4. Masonry Contractor, including Project Foreman.
 - 5. Masonry Inspector.
 - 6. Testing Laboratory.
 - 7. Authorities having jurisdiction.
 - 8. Other interested parties.
- B. Review methods and procedures related to masonry construction including, but not limited to, the following:
 - 1. Review submittals, including
 - a. Brick.

- b. CMU.
 - c. Reinforcing steel shop drawings.
 - d. Masonry accessories.
 - e. CMU/precast concrete lintels.
 - f. Grout type, proportions, and mix designs.
2. Review
 - a. Masonry inspection procedures.
 - b. Grout and grouting procedures.
 - c. Mortar and grout testing procedures.
 - d. Vertical and horizontal steel reinforcing shop drawings, splice lengths, and bar positioners.
 - e. Movement joint locations and details.
 - f. Flashing details.
 - g. Hot/cold weather procedures.
 - h. Approved Masonry Material Cleaning Plan.
 - i. Coordination issues with other trades.
 - j. Protection of and scheduling of non-masonry construction that will interfere with masonry work.
 - k. Job-Site storage and staging areas.
 3. Review mock-ups for workmanship and materials.
 4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 5. 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.

1.12 DELIVERY, STORAGE, AND PROTECTION

- A. Deliver masonry materials to project site in undamaged condition.
- B. Store masonry units off the ground, under cover, and in a dry location to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not place until units are in an air-dried condition.
- C. Store cementitious materials off the ground, under cover, and in dry location.
- D. Store aggregate where grading and other required characteristics can be maintained and contamination avoided.
- E. Store masonry accessories including metal items to prevent corrosion and accumulation of dirt and oil.

1.13 PROJECT CONDITIONS

- A. Protection of Masonry: During erection, 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 minimum 24 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 minimum 24 inches down face next to constructed wythe and hold cover in place.

- B. 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.
- C. Stain Prevention: Prevent grout, mortar and soil from staining the face of masonry to be left exposed or painted. Remove immediately any grout, mortar and soil that comes in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and mortar spatter by means of coverings spread on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes from mortar droppings.

1.14 ENVIRONMENTAL REQUIREMENTS

- A. Cold Weather Construction: Comply with referenced standard and the following:
 - 1. Do not use frozen materials or materials mixed or coated with ice or frost.
 - 2. Do not build on frozen subgrade or setting beds.
 - 3. Do not lay masonry units that are wet or frozen.
 - 4. Remove and replace masonry damaged by freezing conditions. Replaced work shall match in-place work.
- B. Hot Weather Construction: Comply with referenced standard and the following:
 - 1. Protect unit masonry work when temperature and humidity cause excessive evaporation of water from mortar and grout.
 - 2. Provide artificial shade and windbreaks as required.
 - 3. Do not proceed with masonry work when temperatures exceed 100 degF.

PART 2 PRODUCTS

2.01 BRICK MASONRY UNITS

- A. General: Comply with referenced standards and other requirements indicated below applicable to each form of brick unit required.
- B. Provide special brick shapes as follows:
 - 1. For applications requiring brick of form, size and finish on exposed surfaces which cannot be produced from standard brick sizes by sawing.
 - 2. For applications where stretcher units cannot accommodate special conditions including those at corners, movement joints, bond beams, sashes and lintels.
 - 3. For "Lip Brick" applications at lintels, shelf angles, and similar locations.
 - 4. For applications where shapes produced by sawing would leave sawed surfaces exposed to view.
 - 5. For sills, caps, rowlocks, and similar applications resulting in exposure of brick surfaces which otherwise would be concealed from view, provide uncured or unfroged units with all exposed surfaces finished.
 - 6. Provide mitered and epoxied bricks as required to achieve configurations indicated on Drawings.
- C. Face Brick (Type A): ASTM C 216 and as follows: Provide test reports as indicated in Part One Quality Control.
 - 1. Provide brick units tested per ASTM C 67, and rated "Non-Effloresced".
 - 2. Grade: SW.
 - 3. Type: FBX.
 - 4. Compressive Strength: 13,858 psi, average, per ASTM C 67.
 - 5. Size: Modular; 3 5/8 inches thick by 7 5/8 inches high by 7 5/8 inches long.
 - 6. Colors/Textures: W56 / Velour

7. Basis of Design: Glen Gary Brick Co. Hanley plant available through Brick Tech Architectural Inc. 3040 11 Mile Rd, Berkley, MI 48072. Phone: 248-548-0777.
- D. Face Brick (Type B): ASTM C 216 and as follows: Provide test reports as indicated in Part One Quality Control.
1. Provide brick units tested per ASTM C 67, and rated "Non-Effloresced".
 2. Grade: SW.
 3. Type: FBX.
 4. Compressive Strength: 11,113 psi, average, per ASTM C 67.
 5. Size: Modular; 3 5/8 inches by 2 1/4 inches by 7 5/8 inches
 6. Colors/Textures: Black Diamond / Velour
 7. Basis of Design: Cloud Ceramics Inc. available through Brick Tech Architectural Inc. 3040 11 Mile Rd. Berkley, MI 48072 Phone: 248-548-0777.

2.02 CONCRETE MASONRY UNITS

- A. General: Comply with requirements indicated below applicable to each form of concrete masonry unit required.
1. Provide special shapes where indicated and as follows:
 - a. For lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
 - b. Bullnose units for exposed outside corners unless otherwise indicated.
 2. Size: Manufacturer to specified dimensions of 3/8 inch less than nominal widths by nominal heights by nominal lengths indicated on Drawings.
 3. Core Construction: Two or three at Contractor's option unless otherwise shown. Coordinate with wall reinforcement spacing.
 4. Exposed Faces: Manufacturer's standard color and texture unless noted otherwise.
- B. Hollow Load-Bearing Concrete Masonry Units: ASTM C 90, and as follows:
1. Minimum compressive prism strength: 2000 psi.
 2. Weight classification: Medium weight.
 3. Weight classification: Normal weight.
- C. Solid Load-Bearing Concrete Masonry Units: ASTM C 90, and as follows:
1. Minimum compressive prism strength: 2000 psi.
 2. Weight classification: Normal weight.
- D. Decorative Concrete Masonry Units (DCMU): ASTM C 90, and as follows:
1. Minimum compressive prism strength: 2000 psi.
 2. Weight classification: Normal weight.
 3. Finish: Exposed faces of the following descriptions matching color, pattern, and texture of Architect's sample.
 - a. Ground finish and integral color with center score.
 - b. Color: National Block Co.; "Perma Grind Flax" 3900 Ford Road, Westland, MI. 48185. Phone Number: 734-721-4056.
 4. Apply one coat of sealer to face of decorative units at factory.
 - a. Factory to furnish sufficient quantity of sealer for one field applied coat of sealer to be applied after walls are constructed and cleaned.
 5. Integral Water Repellant at Exterior CMU: Provide units produced with liquid polymeric, integral water-repellant admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellant manufacturer's mortar additive, per ASTM E 514, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen.
 6. Use water repellent admixtures for masonry units, mortar and grout by a single manufacturer.

7. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Decorative Concrete Masonry Units:
 - 1) Best Block Company.
 - 2) Grand Blanc Cement Products.
 - 3) National Block Company.
 - b. Integral Water Repellant:
 - 1) BASF; Rheopel Plus
 - 2) W. R. Grace & Co.; Dry Block.

2.03 CONCRETE AND MASONRY LINTELS

- A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
 1. Prefabricated lintels shall conform to ASTM C 1623.

2.04 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold weather construction. Provide natural or white color cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Masonry Cement: ASTM C 91.
- D. Aggregate for Mortar: ASTM C 144; for joints less than 1/4 inch, use aggregate graded with 100 percent passing No. 16 sieve.
- E. Aggregate for Grout: ASTM C 404.
- F. Water: Clean and potable.
- G. Water-Repellant Admixture: Liquid water-repellant mortar admixture intended for use with CMU, containing same integral water repellant by same manufacturer.

2.05 REINFORCING STEEL

- A. General: Provide reinforcing steel complying with requirements of referenced unit masonry standard and with this article.
- B. Steel Reinforcing Bars: Billet steel, ASTM A 615, Grade 60.
 1. Reinforcing Bars Positioners: Provide reinforcing bar positioners to assist with reinforcing placement in the center of the masonry unit.

2.06 JOINT REINFORCEMENT

- A. General: Provide joint reinforcement per ASTM A 951, formed from the following:
 1. Galvanized carbon steel wire: ASTM A 82, galvanized per ASTM A 153, Class B-2 coating, for interior and exterior walls.
- B. Description: Welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet, complying with requirements indicated below.
 1. Wire Diameter for Side Rods: 0.1483 inch (9 gage).

2. Wire Diameter for Cross Rods: 0.1483 inch (9 gage).
3. Wire Diameter for Eyes and Pintles: 3/16 inch.
4. For single-wythe masonry provide type as follows with single pair of side rods:
 - a. Ladder design with perpendicular cross rods spaced not more than 16 inches o.c.
5. For multiwythe masonry provide type as follows:
 - a. Cavity Masonry Walls.
 - 1) Ladder design with perpendicular side rods and adjustable double eye and pintle type ties.
 - (a) Provide one side rod for each face shell of hollow masonry units more than 4 inches in nominal width.
 - (b) Perpendicular cross rods spaced not more than 16 inches o.c.
 - (c) Adjustable eye and pintle ties spaced not more than 16 inches o.c.
- C. Manufacturers: Subject to compliance with requirements, provide joint reinforcement by one of the following:
 1. Heckman Building Products, Inc.
 2. Hohmann & Barnard, Inc.
 3. Wire-Bond

2.07 TIES AND ANCHORS, GENERAL

- A. General: Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of referenced unit masonry standard and of this article.
- B. Galvanized Carbon Steel Wire: ASTM A 82, galvanized per ASTM A 153, Class B-2 coating.
 1. Wire Diameter: 0.1875 inch.
- C. Galvanized Steel Sheet: ASTM A 366 (commercial quality) cold-rolled carbon steel sheet, hot-dip galvanized after fabrication per ASTM A 924, Class B2 (for unit lengths over 15 inches) and Class B3 (for unit lengths under 15 inches) and Class B3 (for unit lengths under 15 inches), for sheet metal ties and anchors.
 1. Sheet Thickness: 0.0747 inch (14 gage).
- D. Galvanized Heavy-Thickness Steel Sheet: ASTM A 635 (commercial quality) hot-rolled carbon steel sheet hot-dip galvanized after fabrication per ASTM A 924, Class B3, for rigid anchors fabricated from steel sheet or strip with a thickness of 0.180 inch and greater.
- E. Manufacturers: Subject to compliance with requirements, provide products of the following:
 1. Heckman Building Products, Inc.
 2. Hohmann & Barnard, Inc.
 3. Wire-Bond

2.08 BENT WIRE TIES

- A. Individual units prefabricated from bent wire to comply with requirements indicated below.
- B. Tie Shape for Hollow Masonry Units Laid with Cell Vertical: Rectangular with closed ends and not less than 4 inches wide.
- C. Tie Shape for Solid Masonry Unit Construction: Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long.
- D. Type of Masonry Where Coursing Between Wythes Align: Unit ties bent from one piece of wire.
- E. Type for Masonry Where Coursing Between Wythes Does Not Align: Adjustable ties composed of two parts, one with pintles, the other with eyes, maximum misalignment 1-1/4 inches.
- F. Type for Masonry Where Wythes Are Different Materials: Adjustable ties composed of two parts, one with pintles, the other with eyes, maximum misalignment 1-1/4 inches.

2.09 FLEXIBLE ANCHORS FOR CONNECTING TO STEEL FRAME

- A. Adjustable Anchors for Connecting to Structure: Provide two-piece assembly that allows vertical and horizontal movement but resists tension and compression forces perpendicular to plane of wall.
 - 1. Anchor Section: 14 gage or 1/8 inch thick by 7 inches high with 1 inch bend for welding to beam. Slot for wire tie is 5 inches high positioned within 2 inches of the inside face of masonry.
 - a. Heckman; No. 308 Receptacle Slot Anchor.
 - 2. Tie Section: Rectangular-shaped wire tie, 3 or 4 inches wide sized to extend within 2 inch of masonry face, made from 0.1875-inch-diameter, hot-dip galvanized steel wire.
 - a. Heckman; No. 314 Tie Clip Anchor.
- B. Joint Stabilizing Anchors: Single-piece assembly with sliding rods held in receiver which allows vertical and horizontal movement but resists tension and compression forces perpendicular to plane of wall.
 - 1. Receiver Section: Fabricated with stainless steel 1/32 inch sheet steel sleeves, one side embedded in masonry, the other connected to the steel frame with self tapping screws for full capacity of the anchor assembly.
 - 2. Tie Section: Two 8 gage stainless wires encased in plastic sleeves held in the receiver section.
 - a. Hohmann & Barnard; Slip-Set Stabilizer.
 - b. Wire-Bond; No. 1700.

2.10 RIGID ANCHORS

- A. Provide straps of form and length indicated, fabricated from metal strips of the following width and thickness:
 - 1. 1-1/2 inches wide by 1/4 inch thick.
 - 2. Galvanize per ASTM A 153.

2.11 ADJUSTABLE MASONRY VENEER ANCHORS

- A. Dovetail Masonry Veneer Anchors: Units consisting of a metal dovetail shaped clip and wire tie.
 - 1. Wire Tie Shape: Triangular.
 - 2. Wire Tie Length: As required to extend 1-1/2 inches into masonry wythe of veneer face.
- B. Products: Subject to compliance with requirements, provide the following:
 - 1. Dovetail Masonry Veneer Anchors:
 - a. Heckman Building Products, Inc.; 103 Dovetail Triangular Wire Tie.
 - b. Hohmann and Barnard, Inc.; 315 Flexible Dovetail Brick Tie.
 - c. Wire-Bond; No. 2102 with Triangular Tie.

2.12 POSTINSTALLED ANCHORS

- A. Chemical, expansion or undercut anchors as indicated or required, with capability to sustain, without failure, load imposed within factors of safety indicated, as determined by testing per ASTM E 488, conducted by a qualified independent testing laboratory.
 - 1. Corrosion Protection: Stainless steel components per ASTM F 593 and ASTM F 594, Group 1, alloy 304 or 316 for bolts and nuts; alloy 304 or 316 anchors.
- B. For Postinstalled Anchors in Concrete: Capability to sustain, without failure, a load equal to 4 times load imposed by masonry.

- C. For Postinstalled Anchors in Grouted Concrete Masonry Units: Capability to sustain, without failure, a load equal to 6 times load imposed by masonry, per ASTM E 488.

2.13 EMBEDDED FLASHING MATERIALS

- A. Metal Drip Edges: ASTM A 167, Type 304, stainless steel, 0.0156 inches thick.
 - 1. Metal Configuration: Extend at least 3 inches horizontally into wall and 1/2 inch out from exterior face of wall with outer edge bent down 20 degrees and hemmed.
 - 2. Sealant : One part non-skinning butyl sealant conforming to ASTM 1311.
- B. Sheet Metal Flashing: Fabricate from the following metal complying with requirements specified in Section 07 6200 - Sheet Metal Flashing and Trim, and as follows:
 - 1. Stainless Steel: 0.0156 inch thick.
 - 2. Galvanized Sheet Steel: 0.0276 inch thick.
 - 3. Fabricate through-wall metal flashings embedded in masonry with ribs formed in dovetail pattern at 3 inch intervals along length of flashing to provide a three-way integral mortar bond and weep-hole drainage.
- C. Membrane flashing - Laminated Flashing: Manufacturer's standard asphalt-free laminate flashing of type indicated below:
 - 1. Stainless Steel-Fabric Laminate: Stainless steel sheet, laminated to a polymer scrim with asphalt free adhesive.
 - a. Stainless steel type: 304, ASTM A167.
 - b. Fabric: Polymer fabric; laminated back face of stainless steel core.
 - c. Size: Manufacturer's standard width rolls.
 - 2. Provide prefabricated inside corners, outside corners and end dams in lieu of field fabricated inside corners, outside corners and end dams at contractor's option.
- D. Sealant for Flashing: One-part non-skinning butyl per ASTM C 1311.

2.14 MISCELLANEOUS MASONRY ACCESSORIES

- A. Bond Breaker Strips: Asphalt-saturated organic roofing per ASTM D 226, Type I (No. 15 asphalt felt).
- B. Preformed Control-Joint Gaskets: Designed to fit standard sash block unit and maintain lateral stability in masonry wall; size and configuration as indicated.
 - 1. Styrene-Butadiene Rubber: ASTM D 2000, Designation M2AA-805.
 - 2. Polyvinyl Chloride: ASTM D 2287, General Purpose Grade, Type PVC-65406.
- C. Isolation Material: Asphalt impregnated boxboard.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cranco Industries; Brak-Bond.
 - b. Williams Products; Column Box Board
- D. Reglets: Minimum 26 ga. stainless steel, Type 304. Provide reglet with angled slot and foam filler designed for embedment in precast concrete.
 - 1. Product: Subject to compliance with requirements, provide the following
 - a. Heckman Building Products; No. 231 Stay-Put Flashing Reglet.
- E. Grout Retainer: Mesh screen, width of CMU less 1 inch, for use at bottom of open cells of CMU to retain grout without use of special shaped unit.
- F. Dovetail Anchor Slots: Minimum 22 ga. stainless steel, Type 304. Provide 1 inch by 1 inch slot with 5/8 inch throat opening. Fill slot with temporary foam filler to prevent intrusion of concrete or debris.
 - 1. Product: Subject to compliance with requirements, provide one of the following:
 - a. Heckman Building Products, Inc.; No. 100 Dovetail Slot.
 - b. Hohmann and Barnard, Inc.; No. 305 Dovetail Slot.

- c. Wire-Bond; No. 1304 Dovetail Slot.
- G. Cavity Drainage Material: Reticulated, non-absorbent mesh, made from polyethylene strands and shaped to maintain drainage at weep holes without being clogged with mortar droppings.
 - 1. Provide thickness to fill cavity, but not less than 2 inch thickness.
 - 2. Subject to compliance with requirements, provide the following:
 - a. Mortar Net USA Ltd.; Mortar Net.
- H. Weep Vents: 1/2 inch thick, non-absorbent 200 denier polyester mesh with 90 percent open weave.
 - 1. Color: As selected by Architect.
 - 2. Products: Subject to compliance with requirements, provide the following:
 - a. Mortar Net USA Ltd.; Mortar Net Weep Vents.
 - b. CavClear Inc.; CavClear Weep Vents.

2.15 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of trisodium phosphate (1/2 cup dry measure) and laundry detergent (1/2 cup dry measure) dissolved in one gallon of water.
- B. Proprietary Acidic Cleaner: Manufacturer's standard-strength, general purpose cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry surfaces of type indicated below without discoloring or damaging masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned.
 - 1. For masonry not subject to metallic oxidation stains, use formulation consisting of a concentrated blend of surface-acting acids, chelating, and wetting agents.
 - 2. For dark colored masonry not subject to metallic oxidation stains, use formulation consisting of a liquid blend of surface-acting acids and special inhibitors.
 - 3. For masonry subject to metallic oxidation stains, use formulation consisting of a liquid blend of organic and inorganic acids and special inhibitors.
 - 4. Product: Subject to compliance with requirements, provide the following:
 - a. ProSoCo, Inc.; Sure Klean No. 600 Detergent
 - b. ProSoCo, Inc.; Sure Klean No. 101 Lime Solvent.
 - c. ProSoCo, Inc.; Sure Klean Vana Trol

2.16 MORTAR AND GROUT MIXES

- A. General: Do not add admixtures including coloring pigments, air-entraining agents, accelerating or retarding agents, anti-freeze compounds, or other admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
- B. Mortar for Unit Masonry: ASTM C 270, Property Specification.
 - 1. Use Type M or S mortar for all masonry below grade.
 - 2. Use Type S mortar for all masonry above grade.
 - 3. Use Type N mortar for exterior above grade veneer walls and parapets, interior load bearing and non-load bearing partitions, and other uses not indicated.
 - 4. Use Type S mortar for reinforced masonry.
- C. Standard Grout Mix: ASTM C 476.
 - 1. Fine or coarse grout per ACI 530.1/ASCE 6/TMS 602, Table 1.15.1, Grout Space Requirements, based on height and CMU cell size.
 - 2. Provide grout with slump of 8 inches to 11 inches, per ASTM C 143.
 - 3. Provide 3,000 psi, 28 day compressive strength unless otherwise indicated.
 - 4. Grout for hollow metal door frames slump must not exceed 4 inches, per ASTM C143. Hand trowel grout into frames, do not pump.

- D. Self-Consolidating Grout Mix: Material requirements of ASTM C 476.
 - 1. Provide fine or coarse grout.
 - 2. Minimum Compressive Strength of 3,000 psi, 28 day compressive strength.
 - 3. Has a slump flow of 24 to 30 inches per ASTM C 1611, within 10 minutes.
 - a. No bleed water at edge of pat.
 - b. No clumps of aggregate.
 - 4. Has a Visual Stability Index (VSI) less than or equal to 1 per ASTM C 1611, Appendix X.1.
 - 5. Job-Site proportioning of self-consolidating grout is NOT PERMITTED.
 - 6. Field addition of water and admixtures NOT PERMITTED.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other specific conditions, and other conditions affecting performance of unit masonry.
- B. Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Comply with ACI 530/ASCE 5/TMS 402 and ACI 530.1/ASCE 6/TMS 602, except where exceeded by Contract Documents.
- B. Thickness:
 - 1. Build cavity and composite walls and other masonry construction to full thickness shown.
 - 2. Build single-wythe walls to actual thickness of masonry units, using units of nominal thickness indicated.
- C. Build chases and recesses as shown or required to accommodate items specified in this and other Sections of the Specifications. Provide not less than 8 inches of masonry between chase or recess and jamb of openings and between adjacent chases and recesses.
- D. Leave opening for equipment to be installed before completion of masonry. After installation of equipment, complete masonry to match construction immediately adjacent to the opening.
- E. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting where possible.
- F. Anchor Bolts: Set 3/4" diameter anchor bolts at exterior and interior bearing walls as indicated on structural drawings.
- G. Cleaning Reinforcing: Remove rust, mud, ice and other coatings from reinforcing prior to placing.

3.03 CONSTRUCTION TOLERANCES

- A. Comply with construction tolerances of ACI 530.1/ASCE 6/TMS 602.
 - 1. For vertical lines, such as vertical corners, door jambs, reveals, and movement joints: Maximum from plumb; 1/4 inch in 20 feet.
 - 2. For horizontal lines, such as lintels, sills, parapets, and reveals: Maximum from level; 1/4 inch in 20 feet.
 - 3. Joint Thickness:

- a. Bed Joints: Plus or minus 1/8 inch.
- b. Head Joints: Minus 1/8 inch, plus 1/4 inch.

3.04 LAYING MASONRY WALLS

- A. Lay out of walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate location openings, movement type joints, returns and offsets. Avoid the use of less-than-half size units at corners, jambs and where possible at other locations.
- B. Lay up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.
- C. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond patterns unless indicated otherwise; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
 - 1. Brick: Standard 1/2 running bond.
 - 2. Standard CMU: Standard 1/2 running bond.
 - 3. Decorative CMU: 1/4 running bond.
- D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- E. Stopping and Resuming Work: In each course, rack back 1/2 unit length for one-half running bond or 1/3 unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly (if required) and remove loose masonry units and mortar prior to laying fresh masonry.
- F. Built-In Work: As construction progresses, build-in items specified under this and other Sections of the Specifications. Fill in solidly with mortar around built-in items.
 - 1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.
 - 2. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.
 - 3. Fill cores in hollow concrete masonry units with grout 3 courses (24 inches) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
- G. Non-loadbearing Interior Partitions: Build full height of story to underside of solid floor or roof structure above and as follows:
 - 1. Install pressure-relieving joint filler in joint between top of partition and underside of structure above.

3.05 MORTAR BEDDING AND JOINTING

- A. Lay hollow concrete masonry units as follows:
 - 1. With full mortar coverage on horizontal and vertical face shells.
 - 2. Bed webs in mortar in starting course on footings and in all courses of piers, columns and pilasters, and where adjacent to cells or cavities to be filled with grout.
 - 3. For starting course on footings where cells are not grouted, spread out mortar bed, including areas under cells.
 - 4. Maintain joint widths indicated, except for minor variations required to maintain bond alignment. If joint width not indicated, use 3/8 inch width.
 - a. Joint Width Tolerance: Plus 1/16 inch, minus 0.
 - 5. Point score joints in DCMU with mortar to match standard tooled mortar joints.
- B. Lay brick masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not furrow bed joints or slush joints.
 - 1. At cavity walls, slope beds toward cavity to minimize mortar protrusions into cavity. As work progresses, trowel mortar fins protruding into cavity flat against face of brick.

- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
- D. Cut joints flush for masonry walls to be concealed or to be covered by other materials, unless otherwise indicated.
- E. Lay concrete unit masonry using beveling technique described in BIA Technical Note No. 21C.

3.06 BONDING OF MULTI-WYTHE MASONRY

- A. Bond multiwythe walls together using one of the following methods:
 1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 1.77 sq. ft. of wall area spaced not to exceed 16 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.
 - a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
 - b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type ties to allow for differential movement regardless of whether bed joints align.
 2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
 - b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
 - c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in back-up wythe attached to adjustable eye and pintle type ties to allow for differential movement regardless of whether bed joints align.

3.07 CAVITIES/AIR SPACES

- A. Keep cavities/air spaces clean of mortar droppings and other materials during construction. Strike joints facing cavities/air spaces flush.
- B. Tie exterior wythe to backup with continuous horizontal joint reinforcing or individual metal ties as shown.
- C. Place cavity drainage material immediately above embedded flashing.

3.08 HORIZONTAL JOINT REINFORCEMENT

- A. General: Provide continuous horizontal joint reinforcement as indicated. Where there are dissimilar masonry materials install continuous horizontal joint reinforcement in horizontal joint between those materials. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inches elsewhere. Lap reinforcing minimum 6 inches.
 1. Space reinforcement maximum 16 inches o.c. vertically.
 2. Space reinforcement maximum 8 inches o.c. vertically, in foundation walls and parapet walls.
 3. Provide reinforcement maximum 8 inches above and below wall openings and extending minimum 12 inches beyond openings.
 4. Provide reinforcement at all joints between brick veneer and cast stone and manufactured stone masonry.

- B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections.
- D. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.09 ANCHORING MASONRY TO STRUCTURAL MEMBERS

- A. Anchor masonry to structural members where masonry abuts faces of structural members to comply with the following:
 - 1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar or other rigid materials.
 - 2. Anchor masonry to structural members with flexible anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not less than 24 inches o.c. vertically and 32 inches o.c. horizontally.

3.10 ANCHORING SINGLE-WYTHE MASONRY VENEER

- A. Anchor single-wythe masonry veneer to concrete with masonry veneer anchors to comply with the following requirements:
 - 1. Place dovetail of each anchor section into vertical dovetail shaped slots in concrete substrate.
 - 2. Embed tie section in masonry joint. Provide not less than 1-inch air space between back of masonry veneer wythe and concrete substrate.
 - 3. Space anchors as indicated but not more than 16 inches o.c. vertically with not less than one anchor for each two square feet of wall area.

3.11 MOVEMENT JOINTS

- A. Install control and expansion joints in unit masonry assemblies where indicated. Build in related items as masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.
- B. Form control joints in concrete masonry as follows, using bond breaker strips and filled joint:
 - 1. Location and spacing of control joints shall comply with industry standards.
 - 2. Fit bond breaker strips into hollow contour in ends of block units on one side of control joint. Fill the resultant core with grout and rake joints in exposed faces.
 - 3. Install preformed control-joint gaskets designed to fit standard sash block.
- C. Form expansion joints in brick as follows:
 - 1. Build in joint filler materials where indicated.
 - 2. Form open joint of width indicated, but not less than 3/8 inch wide for installation of sealant and backer rod as specified in Section 07 92 00 - Joint Sealants. Maintain joint free and clear of mortar.
- D. Build in horizontal pressure-relieving joints where indicated; construct joints by either leaving an air space or inserting nonmetallic 50 percent compressible joint filler of width required to permit installation of sealant and backer rod specified in Section 07 92 00 - Joint Sealants.
 - 1. Locate horizontal pressure-relieving joints beneath shelf angles supporting masonry veneer and attached to structure behind masonry veneer.

3.12 LINTELS

- A. Install steel lintels where indicated.
- B. Provide masonry lintels where shown and wherever openings of more than 1'-0" for brick size units and 2'-0" for block size units are shown without structural steel or other supporting lintels.
 - 1. Provide prefabricated lintels per ASTM C 1623, or formed-in-place masonry lintels. Temporarily support formed-in-place lintels.
 - a. For hollow concrete masonry unit walls, use specially formed bond beam units with reinforcement bars placed as indicated and filled with course grout.
- C. Provide minimum bearing at 8 inches at each jamb, unless otherwise indicated.

3.13 FLASHING, WEEP HOLES, AND VENTS

- A. Install embedded flashing and weep holes in masonry at base of walls, shelf angles, lintels, ledges, other obstructions to the downward flow of water in wall, and where indicated.
- B. Prepare masonry surfaces smooth and free from projections that could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with adhesive/sealant/tape as recommended by flashing manufacturer before covering with mortar.
- C. Install flashings as follows:
 - 1. At lintels and shelf angles, extend flashing minimum 4 inches into masonry at each end. Extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 12 inches, and behind vapor retarder.
 - a. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2 inches, unless otherwise indicated.
 - 2. At heads and sills, extend flashing a minimum 4 inches into masonry at each end. Turn up ends not less than 2 inches to form an end dam. Where using stainless steel fabric flashing form end dams from stainless steel sheet metal.
 - 3. At base of masonry cavity walls, extend flashing from exterior face of exterior wythe, through exterior wythe, up face of interior wythe at least 8 inches and fasten with a termination bar. Fasten to face of interior wythe with termination bar.
 - 4. At step flashing, turn up ends not less than 2 inches to form an end dam, at the ends of each step. Where using stainless steel fabric flashing form end dams from stainless steel metal.
 - 5. Extend sheet metal flashings 1/2 inch beyond face of wall and turn down to form a drip. At sheet metal flashings within 42 inches of grade only, trim flashing flush with the face of the wall.
 - a. Drip edges extending from face of wall shall be hemmed.
 - 6. Provide bead of butyl sealant at top of all termination bars.
- D. Install reglets and nailers for flashing and other related construction where shown to be built into masonry.

3.14 REINFORCED UNIT MASONRY INSTALLATION

- A. Install reinforced unit masonry to comply with requirements of referenced unit masonry standard.
- B. Temporary Formwork and Shores: Construct formwork and shores to support reinforced masonry elements during construction.

1. Construct formwork to conform to shape, line, and dimensions shown. Make 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 other temporary loads placed on them during construction.
- C. Temporary Wind Bracing
1. Provide temporary masonry wall bracing to MIOSHA Construction Safety Standards, Part 2: Masonry Wall Bracing.
 2. The limited access zone shall be equal to the height of the wall to be constructed plus four feet, and shall run the entire length of wall.
 3. Provide temporary wind bracing at masonry foundation walls and at other interior and exterior masonry free-standing walls exceeding 8'-0" in height according to MOSHA maximum unsupported wall heights.
 4. Bracing may be of metal or wood material capable of resisting uniform lateral wind pressures of 70 miles per hour.
 5. Engineer and construct temporary wind bracing system as part of base contract.
- D. Placing Reinforcement: Comply with ACI 530.1/ASCE 6/TMS 602.
- E. Grouting: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
1. Grout cores of all masonry at locations of vertical reinforcement, bond beams, bearing plates, anchors and embedded items.
 2. Comply with ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 3. Vertical grout pour heights:
 - a. Standard Grout: Not more than 48 inches.
 - b. Self-Consolidating Grout: As determined with "Grout Demonstration Panel".

3.15 PARTITION IDENTIFICATION

- A. Place identification on all partitions indicated on Drawings as requiring opening protectives, including walls having a required fire or smoke rating.
- B. Identification shall be located in accessible concealed floor, floor-ceiling or attic spaces and as follows:
 1. Locate: Within 15 feet of the end of each wall and at intervals not exceeding 30 feet measured horizontally along wall or partition.
 2. Lettering: Not less than 3 inches in height with a minimum stroke width of 3/8 inches. Use a color that contrasts with the substrate and incorporate the same rating/designation as indicated on drawings and include the suggested wording " FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS".

3.16 FIELD QUALITY CONTROL

- A. Inspectors: Owner will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
 1. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.
- B. Testing Agency: Contractor will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports. Perform inspections as required to satisfy Section 1.6 of the 2005 MSJC Code, Level 3 Quality Assurance. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
 1. Payment for these services will be made by Owner.

2. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.
 3. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.
- C. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
 - D. Clay Masonry Unit Test: For each type of unit provided, per ASTM C 67.
 - E. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.
 - F. Mortar Test (Property Specification): For each mix provided, per ASTM C 780.
 - G. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.
 - H. Self-Consolidating Grout: As delivered to site, verification of slump flow and Visual Stability Index (VSI) per ASTM C 1611.

3.17 REPAIRING, POINTING AND CLEANING

- A. Remove and replace masonry units that are loose chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units and in fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings, and adjacent construction to provide a neat, uniform appearance. Prepare joints for application of sealants.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears prior to tooling joints.
- D. Final cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 1. Remove large mortar particles by hand with wooden paddles and non-metallic scrape hoes or chisels.
 2. Comply with manufacturer's specifications and recommendations for use of masonry cleaner products.
 3. Test cleaning methods on sample wall panel; leave 1/2 panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 4. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
 5. Wet wall surface with water prior to application of cleaners; remove cleaners promptly by rinsing thoroughly with clean water.
 6. Clean brick by means of bucket and brush hand-cleaning method described in BIA Technical Note No. 20 Revised, first using job-mixed detergent solution. If result is not satisfactory, use proprietary acidic cleaner applied in compliance with directions of acidic cleaner manufacturer.
 7. Clean concrete masonry by means of cleaning method indicated in NCMA TEK 8-2 applicable to type of stain present on exposed surfaces.
- E. Protection: Provide final protection and maintain conditions, in manner acceptable to installer to ensure unit masonry is without damage and deterioration at time of Substantial Completion.

3.18 SEALER

- A. Apply one coat of sealer to decorative masonry unit walls after cleaning.
- B. Apply sealer in conformance with manufacturer's recommendations.

END OF SECTION 04 2000

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.
- 4. Grout.

- 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.

- 6. Nonshrink grout.
- 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-hex 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.
 2. Nuts: ASTM A563 (ASTM A563M) heavy hex carbon steel.
 3. Plate Washers: ASTM A36/A36M carbon steel. Coordinate requirements with ANSI/AISC 360.J9 and AISC Manual of Steel Construction Table 14-2.
 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.
1. Nuts: ASTM A563 heavy-hex carbon steel.
 2. Plate Washers: ASTM A36/A36M carbon steel.
 3. Washers: ASTM F436, Type 1, hardened carbon steel.
 4. Finish: Plain.
- G. Threaded Rods: ASTM A36/A36M Typically or ASTM A572/A572M, Grade 50 as indicated.
1. Nuts: ASTM A563 heavy-hex carbon steel.
 2. Washers: ASTM A36/A36M carbon steel.
 3. Finish: Plain.
- H. **Clevises and Turnbuckles**]: Made from cold-finished carbon steel bars, ASTM A108, Grade 1035.
- I. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1030.
- J. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1018.

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 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

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.
 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.
 3. Surfaces of high-strength bolted, slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 5. Galvanized surfaces.
 6. Surfaces enclosed in interior construction.

- 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.
 - 3. Ultrasonic Inspection: ASTM E164.
 - 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.
- B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
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 052100 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.
- B.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. K-series steel joists.
 - 2. KCS-type K-series steel joists.
 - 3. Long-span steel joists LH and DLH.
 - 4. Joist accessories.
- 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 where a plaster ceiling is attached or suspended; 1/240 of the span for all other cases.
 - 3.

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

- A. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, under-slung ends, and parallel top chord.
 - 1. Joist Type: K-series steel joists and KCS-type 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:
 - 1. Joist Type: LH-series steel joists and DLH-series steel joists.
 - 2. End Arrangement: Underslung.
 - 3. Top-Chord Arrangement:
 - a. LH: Parallel.
 - b. DLH: Paralel.
- 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.

F.

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.
- D. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.
- 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:
 - 1. Radiographic Testing: ASTM E 94.
 - 2. Magnetic Particle Inspection: ASTM E 709.
 - 3. Ultrasonic Testing: ASTM E 164.
 - 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

SECTION 053100 STEEL DECKING

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.
 - 3. Non-composite form 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.
 - 1. General Contractor and Construction Manager: Review, Stamp and Forward to the 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:

- a. ASC Profiles, Inc.
- b. Canam Steel Corp.;The Canam Manac Group.
- c. Consolidated Systems, Inc.
- d. DACS, Inc.
- e. D-Mac Industries Inc.
- f. Epic Metals Corporation.
- g. Marlyn Steel Decks, Inc.
- h. New Millennium Building Systems, LLC.
- i. Nucor Corp.; Vulcraft Division.
- j. Roof Deck, Inc.
- k. United Steel Deck, Inc.
- l. Valley Joist; Division of EBSCO Industries, Inc.
- m. Vercor Manufacturing Co.
- n. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

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 33, 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 33, 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 33, 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:
 - 1. Weld Diameter: 3/4 inch, nominal.
 - 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:
 - 1. Weld Diameter: 3/4 inch, nominal.
 - 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 2inches, 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.
 - 1. Compliance standard: ANSI/SDI QA/QC-2011 Standard for Quality Control and Quality Assurance for Installation of Steel Deck.
- 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: Upon request from the Architect/Engineer only, 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:
 - a. Dead Loads, Live Loads, and Other Project Loads: As indicated on Construction Documents.
 - 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 $L/600$ of their unsupported height.
 - 2) Metal Panel Veneer Backup: Deflection not over $L/240$ of their unsupported height.
 - b. Vertical Deflection of Joists Under Design Loading:
 - 1) Floor Members: Live Load deflection not over $L/360$ or Total Load Deflection not over $L/240$ of their unsupported length.
 - 2) Ceiling Joist Framing: Vertical deflection of $1/360$ of the span for live loads and $1/240$ 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 $1/2$ 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: Provide bridging for walls that will be unsheathed.
- 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.
1. Fire-Resistance Ratings: Indicated by GA File Numbers in GA-600, "Fire Resistance Design Manual," or by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.

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.
- E. (STL FURG-1) Hat-Shaped Furring Channels: ASTM C 955.
1. Minimum Base-Metal Thickness: 0.0428 inch.
 2. Depth: As shown.
- F. (STL FURG-2) Z-Shaped Furring: ASTM C 955.
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.
 10. Hole reinforcing plates.
 11. Backer plates.
 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.
- G. Vertical Deflection Clips (Drift Clips): Manufacturer's standard bypass clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

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:
 - a. Georgia-Pacific Gypsum: DensGlass Fireguard Sheathing.
 - b. Certainteed: GlasRoc Sheathing.

- c. USG: Securock Glass-Mat Sheathing.
 - d. National Gypsum: eXP Extended Exposure 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 for support of equipment (MSA).
 - 2. Support system engineering and fabrication.
- B. Coordination:
 - 1. Section 054000 - Cold-Formed Metal Framing:

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.
 - 2. Manual of Steel Construction: AISC.
 - 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.
- C. Design and construct system, including anchorage, to withstand forces imposed on support system from equipment attachment.
- D. Verify loading, deflection criteria and tolerance requirements of equipment or construction being supported.
- E. Verify bolting plate assembly requirements with equipment supplier.

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.
 3. G-Strut by Gregory Industries.
 4. Haydon Corporation.
 5. Hilti USA.
 6. Power-Strut.
 7. Unistrut Corporation.
 8. Wesanco, Inc..
- C. (MSA-1) Metal Support Assembly: Shop- or field-fabricated assembly consisting of continuous slot, bolted metal framing channels and all associated fittings and hardware.
- D. Locations/Applications Schedule:
 - 1.
- E. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 1. Basis of Design: P1000 by Unistrut Corporation.
 2. Galvanized steel, ASTM A 653, structural steel, Grade 33, with G90 coating.
 3. Material: Cold-rolled steel, ASTM A 1008, structural steel, Grade 33; hot-dip galvanized after fabrication.
- F. Fittings: Formed or stamped steel nuts, bolts, washers and other devices designed to fit into channel slot and prevent slipping along channel.
 1. Fitting Material: ASTM A575, A576, A635 or A36.
 2. Bolt & Nut Material: Regular hexagon-head bolts, ASTM A307 Grade A; hex nuts ASTM A563; and where indicated, flat washers.
 3. Plain Washers: Round carbon steel, ASME B 18.22.1
 4. Lock Washers: Helical, spring type, carbon steel, ASME B 18.21.1
- G. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- H. 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.
 - a. Color: White (or other) to match suspended acoustical ceiling grid system 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 055000 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.
3. Surface preparation and priming for finishes on ferrous metal, performed in shop:
 - a. Surface preparation;
 - b. Galvanizing;
 - c. Shop primer for paint;
 - d. Shop primer for high-performance coatings;
4. 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.
 3. Welding: Indicate welded connections, both shop and field, using standard AWS welding symbols. Indicate net weld lengths.
- 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 product required units.
- B. Installer Qualifications: Arrange for metal stairs specified in this Section to be fabricated and installed by same firm.
- C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code-Sheet Steel."
- 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.
6. 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.
 - a. Material: Carbon-steel components zinc-plated to comply with ASTM B633, Class Fe/Zn 5.
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.
8. Finish: Shop-applied primer.

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.
 9. 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.
 3. Finish: Shop-prime for high-performance coating (HPC).
- E. (MET FAB-14) Catwalk:
- F. (MET FAB-15) Lighting Support Pipe Rail: ASTM A 53, Schedule 80, 1-1/2 inch i.d.; and stand-offs fabricated from steel shapes, as shown.
1. Finish: Shop-prime for painted finish (PT).
- 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 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.

2.5 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 055005
MISCELLANEOUS METAL FABRICATIONS

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. 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.
 - 6. Shelf angles.
 - 7. Loose bearing and leveling plates.
 - 8. Metal ladders.
- 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.
 - 1. General Contractor and Construction Manager: Review, Stamp and Forward to the 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.
 - 3. Material: Galvanized steel complying with ASTM A 653/A 653M, commercial steel, Type B, with G90 coating.
 - 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.
- F. Plain Washers: Round, ASME B18.22.1.
- G. Lock Washers: Helical, spring type, ASME B18.21.1.
- 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.

1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material for Anchors in Exterior Locations: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

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.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- 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-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

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 at 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

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of 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.

END OF SECTION

SECTION 055100 METAL STAIRS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior exit stair assemblies (MET STAIR-1).
 - 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.
 - 3. Welding: Indicate welded connections, both shop and field, using standard AWS welding symbols. Indicate net weld lengths.
 - 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: 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 product required units.
- B. Installer Qualifications: Arrange for metal stairs specified in this Section to be fabricated and installed by same firm.
- C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code-Sheet Steel."

1.5 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.

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. (MET STAIR-1) 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 steel plates and 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. 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 or steel plate sections, 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 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.
 3. Steel Plates, Shapes and Bars: ASTM A36.
 4. Steel Tubing: ASTM A501 or ASTM A500.
 5. Steel Pipe: ASTM A53, Type S, Grade A, standard weight and extra-strong as required, galvanized and plain.
 6. Galvanized Sheet Metal: ASTM A526 or A527, G-90 coating designation with both sides of metal prime painted.
 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.
 - a. Material: Carbon-steel components zinc-plated to comply with ASTM B633, Class Fe/Zn 5.
 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 3000 psi, unless higher strengths are indicated.

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 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.

2.5 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.
 - 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.
 - 3. Grout, anchoring cement, and paint products.
- 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: (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 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 the following:
 - 1. AWS D1.1, "Structural Welding Code - Steel."
 - 2. AWS D1.2, "Structural Welding Code - Aluminum."
 - 3. AWS D1.3, "Structural Welding Code - Sheet Steel."
 - 4. AWS D1.6, "Structural Welding Code - Stainless Steel."
- 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.
- D. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1.

2.2 INTERIOR FABRICATIONS

- A. (ORN MET-1) Fin-Tube Enclosure: Prefinished, aluminum plate, ASTM B 209; partially perforated as shown; custom formed to shape as shown on Drawings; concealed attachment.
 - 1. Aluminum Sheet: 0.125 inch thick, tension-leveled, smooth aluminum sheet, ASTM B 209.
 - 2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: Black, as selected by Architect.
 - b. Anodize after perforation.
 - 3. Perforation:
 - a. Pattern: Hole shape, size, and spacing as selected by Architect.
 - b. Extent of Pattern: Partial, as shown.
 - c. Minimum Open Area: 45 percent.
- 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: 22 ga. steel sheet, ASTM A 36.
 - 3. Finish: Special blackened finish, matching Architect's sample, and clear protective coating.
 - 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/aluminum] panels w/return,
 - 1. ___" sheet thickness, ___"x___" openings,
 - 2. shop-applied painted finish TBD,
 - 3. Backer:
 - a. fire-rated MDF backer
 - b. painted finish
- D. (ORN MET-5) Wall Base: Metal angle,
 - 1. 1/4" thick,
 - 2. metal plate, 16 ga.
 - 3. welds ground smooth
 - 4. PT-11

2.3 EXTERIOR SCRIM ASSEMBLY WITH DIMENSION LETTERS

- A. ORN MET-6: Stainless steel mesh, ___ by GKD, gold colored _____ finish TBD; anchored at top & bottom to continuous concealed steel supports; two-part (front & back), laser-cut stainless steel plate letters, concealed clipped to mesh
- B. Dimension Letters: Two-piece (front and back) cut-out characters with uniform faces; square-cut, smooth edges; precisely formed lines and profiles; and as follows:
 - 1. Material: Sheet or plate stainless steel.

2. Thickness: **[0.125 inch] [0.25 inch]** .
3. Integral Stainless-Steel Finish: [No. 4] [No. 8] [Match Architect's sample] [As selected by Architect from full range of industry finishes].
4. Mounting: Concealed, stainless-steel clip through mesh.
5. Character Height: As indicated.
6. Typeface: To be determined.
7. Message: <insert building name>

C. ALTERNATE: Illuminated LED mesh by GKD

2.4 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.
 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.
- 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:
 1. Insulation: Unfaced, mineral-fiber blanket insulation complying with ASTM C 665, Type I, and passing ASTM E 136 test.
 2. Mastic: Cold-applied asphalt emulsion complying with ASTM D 1187.
 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.

2.5 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.

2.6 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 057200 ORNAMENTAL RAILINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Custom ornamental handrail and guardrail assemblies (ORN RAIL).
2. 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-4.
 - c. ORN RAIL-5.
 - d. ORN RAIL-6.
 - e. ORN RAIL-7.
 - f. ORN RAIL-8.
 - 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.
 4. *Railing at Audio Porch (ORN RAIL-__)*:
 - a. *Capable of withstanding dead load of countertop, support brackets and audio equipment, plus concentrated rail loads specified above.*
 - b. *Capable of withstanding dead load of countertop, support brackets and audio equipment, plus a concentrated person load of 250 lbf applied downward at any point on countertop; not concurrent with other concentrated rail loads specified above.*
- 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.
 1. Wood Type and Finish: Hardwood (WD-1) as specified in Section 064000 - Architectural Woodwork.
 2. Mounting Brackets: Solid steel rod, 3/8-inch diameter; welded, ground smooth. Welded attachment to posts.
- C. ORN RAIL-4: Handrail, wall-mounted, steel bar, PT-__ finish
- D. ORN RAIL-6: Handrail, floor-mounted (sleeve), steel bar posts & [pipe] top rail, PT-__ finish
- E. ORN RAIL-7: Removable pit guardrail, floor-mounted, concealed steel framing, interlocks, WD FAB-3 cladding, solid WD-2 cap
- F. ORN RAIL-8: Removable lift guardrail, floor-mounted to stage lift platform, steel bar, PT-__ finish

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 Channel for Glass Guardrails: 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, ASTM B 221, Alloy 6063-T5/T52.
- 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.
 - 3. Galvanized-Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
 - 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.
- C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- 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..

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. Glass Railings: Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.
- B. 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 and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.
 - 4. Clean wood rails by wiping with a damp cloth and then wiping dry.
- C. 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.
- D. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
- E. 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.
- F. 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 (WD BLKG-1).
 2. Wood sheathing (WD SHTG).
 3. Preservative treatment (PPT).
 4. Fire-retardant treatment (FRT).
 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.
- B. Plywood Standard: Comply with U. S. Product Standard PS 1-74/ANSI A199.1; and Grades and Specifications, Performance-Rated Panels and Specifications by APA – The Engineered Wood Association local code standard. Each construction and industrial panel shall bear APA trademark and appropriate identification.

- 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.

- C. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
 - 1. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
 - 2. Engineered Wood Products, General: Products shall [contain no urea formaldehyde.] [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."]

2.2 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. (WD BLKG-1) 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

- A. (WD SHTG-1) Concealed Sheathing: APA, C-D touch-sanded plugged. Exposure 1, 3/4 inch, FRT, square edge, Douglas Fir.
- B. (WD SHTG-2) Concealed Sheathing: APA C-D EXT touch-sanded plugged. Exposure Exterior, 3/4 inch, PPT, square edge, Douglas Fir.
- 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 AWWA 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 AWWA 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.
 - a. Distributor: Brock-White Company, Minneapolis, Minnesota.

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

- A. Install plywood in accordance with Plywood Construction Guide by APA – The Engineered Wood Association.
- 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-1), (WD-2) and (WD-5).
 - 2.
 3. Wood-Veneer-Faced Cabinetwork.
 4. Plastic-Laminate-Faced Cabinets and Countertops (PLAM).
 5. Solid Surface Fabrications (SSF).
 6. Wall-Mounted Work Surfaces, Shelves on Brackets and Standards.
 7. Installation Accessories, Anchors and Adhesives.
 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 *(WD FAB-1,4,5,6,8)* and other 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) and (WD-2): 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. Cabinetwork 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: Construct mockups, using same materials to be used for permanent construction, to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution of final Work. Provide the following mockups as described below and as directed by Architect.
1. Submit mockup shop drawings to Architect.
 2. Mockup will serve as Architects review of aesthetic effects and workmanship.
 3. Final selection of materials, system components, configuration, design and other performance and appearance criteria are subject to modification based on review of submittals and mockups.
 4. Obtain Architect's approval of mockups before starting permanent work, fabrication, or permanent construction. Allow 10 days for initial review and each re-review of mockups.
 5. Maintain and protect undisturbed approved mockups throughout construction to serve as a standard for judging completed Work.
 6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- B. Integrated Mockup of Wood Fabrications (WD FAB-2M), Wood Flooring (WDF-1) and Coved Base: Construct full-scale assemblies in shop or in-place at Project site, including:
1. Complete acoustic shell wagon substructure, with fully-operating casters and hardware.
 2. Coordinate with Section 116116 - Adjustable Acoustic Assemblies.
 3. Architectural woodwork, ornamental metal panels and fabric scrim attached to wagon substructure.
 4. Integrated lighting assemblies, if applicable. Coordinate with Section 260961.
 5. Mockup adjacent construction for the purpose of assessing fit and alignment of moveable assembly, and to establish tolerances for final installed Work.
 6. Mockup floor-mounted steel plate guides and guides anchored to structure that receive steel plate guides at top of assembly.
 7. Mockup wood flooring system (WDF) directly beneath (WD FAB) assemblies and extending in front of assemblies, for the purpose of providing floor space for testing and evaluating functional characteristics during typical operations. Architect to determined square footage and extent necessary to test.
 8. Functional characteristics to be tested and evaluated by Owner's personnel, Architect's theatre consultant, Construction Manager and Architect. Architect will make final decision for approval of mockup.
 9. Test mockup for compliance with acoustic requirements. Consult Owner's acoustic consultant for test method. Owner's acoustic consultant to be present during testing.

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 018122 - 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.
- B. Miscellaneous Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.
- C. Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber .
- D. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
1. Class B or Class A Flame Spread Rating: Vesta FR by Sierra Pine.
 2. Class C Flame Spread Rating: Arreis by Sierra Pine.
- E. Hardboard: AHA A135.4.
- F. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.

- G. Softwood Plywood: DOC PS 1, exterior.
- H. Veneer-Faced Plywood: HPVA HP-1, made with adhesive containing no urea formaldehyde.
- I. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.
- J. (WD-1) and (WD-2) Hardwood for Transparent Finish: Match Architect's sample.
 - 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 and WD-2 woodwork.
 - b. Supply wood veneer facing materials for wood doors required to be matched with architectural woodwork.
 - c. Minimum Quality Standard: NAAWS Premium Grade.
- K. WD-1: Red oak, rift-sliced veneer, rift-sawn solid; stain & clear finish
- L. WD-2: Red oak, rift-sliced veneer, rift-sawn solid; stain & clear finish
- M. WD-3: [New/Reclaimed] wood, milled & prefinished. [Source for reclaimed / Species of new] wood and finishes TBD
 - 1. Shop-Applied Transparent Finish: NAAWS System 5 Conversion Varnish.
 - a. Minimum Quality Standard: NAAWS Premium Grade.
 - b. Pre-finish woodwork at shop, defer only final touchup, cleaning, and polishing until after installation.
 - c. Finish all surfaces, faces and edges of woodwork. Back-prime concealed surfaces with two coats of sealer or primer.
 - d. Sheen: Matching Architect's sample.
 - 2. Veneer Matching:
 - a. Matching of Adjacent Veneer Leaves: Book match.
 - 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).
 - e. Door Face Veneers: Supply book-matched wood veneers to Section 081400 - Wood Doors.
 - 3. Solid Hardwood Trim on Wood Fabrications: Match trim for compatibility of grain and color to itself and with veneers.
- N. WD-4: MDF or solid wood, spray-applied finish, varying sheens
- O. (WD-5) Wood Materials for Opaque Painted Finish:
 - 1. Wood Type: Natural Birch or Poplar.
 - 2. Field-Finishing: Shop-apply primer compatible with finishing system in accordance with Section 099000 - Painting.
 - 3. Prefinished: Spray-apply primer and finish coats in shop, defer only final touchup, cleaning, and polishing until after installation.
 - a. Minimum Quality Standard: NAAWS Premium Grade.
 - b. Sheen: Matching Architect's sample.
 - 4. Finish all exposed surfaces, faces and edges of woodwork. Back-prime concealed surfaces with two coats of sealer or primer.

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.
 1. Quality Standard: NAAWS Premium Grade.
 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. WD FAB-1: Sliding pocket doors with ORN MET-3 faces, hardware
- C. WD FAB-2: Wood Donor Wall: TBD
- D. WD FAB-3: Flush Wood Panels: Vertically-oriented installation, WD-2 veneer over MDF core (acoustically-reflective)
- E. WD FAB-4: Articulated Wood Panels: Vertically-oriented WD-4 ribs, of varying widths and depths, built-up to create relief patterns as indicated (acoustically-diffusive)
- F. WD FAB-5: Wood Baffle Ceiling: Built-up MDF, PT-5 finish
- G. WD FAB-6: Proscenium Grillage: Vertically-oriented, solid WD-5 dowels of varying diameters, PT-4/5/6 of various sheens; fastened rigidly, with varying spacing, to steel support framing behind. Provide all accessories required for sound & vibration control.
- H. Fabrication Adhesives: Type as recommended by woodwork fabricator and adhesive manufacturer for intended use. Do not use adhesives that contain urea formaldehyde.
- I. 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.
- J. 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.
- K. 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-2) Wood Wall Base: Solid WD-2, in profile and dimensions as shown on Drawings.
 3. (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:
1. Minimum Quality Standard: NAAWS Custom Grade.
 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.
 5. Minimum Quality Standard: NAAWS Custom Grade.
 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:
1. Minimum Quality Standard: NAAWS Custom Grade.
 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:
1. Minimum Quality Standard: NAAWS Premium Grade.
 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.
 - b. Steel Bar: ASTM A36.
 - 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.
 - a. Basis of Design: KV 208 550 Ultimate L-Bracket Series.
 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.
1. Basis of Design: Series 1752A by McMaster-Carr.
 2. Standards: Single-slotted standard. Spacing of standards not to exceed 18 inches.
 3. Brackets: 540 lbs capacity per pair.
 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
 - a. Basis of Design: Grass Nexis.
 - b. Provide 3 per leaf over 48 inches high, 2 per leaf elsewhere.
 - c. Closers: Provide Quiet Soft-Cushion Closers: Nexis G-Force Soft Closer.
- B. Door and Drawer Pulls:
1. (HDWR-P3): 106.74.913 by Häfele, 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.
 2. (GROM-2) Aluminum Grommet, No Cap: MG Series by Doug Mockett.
 3. (GROM-3) Wood Grommet Cap, No Liner: WG Series by Doug Mockett, matching (WD-___).
 4. (GROM-4) Aluminum Grommet in Solid Surface: MM Series by Doug Mockett, MM-4 satin chrome.
 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. 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.
3. 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 flashings, 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.
 - 1. Basis of Design: Monolithic Membrane 6125EV by American Hydrotech.
 - 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.

- 5. Reinforcing Fabric: Manufacturer's recommended, spun-bonded polyester fabric.
- 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.

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.
 - 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.
 - a. Finish texture of concrete substrate: Wood float finish.
 - 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.
 - 3. Molded-Sheet Drainage Panels: 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. Warranty 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.
 - b. Puncture Resistance: 169 lbf according to ASTM E 154.
 - 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.
 - b. Puncture Resistance: 155 lbf according to ASTM E 154.
 - 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).
 2. Mineral wool batts (INSUL-24).
 3. Spray-foam insulation (INSUL-30).

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.
 1. Surface-Burning Characteristics: ASTM E84.
 2. Fire-Resistance Ratings: ASTM E119.
 3. Combustion Characteristics: ASTM E136.

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

- A. (INSUL-26) Mineral Wool Rigid Board Insulation: ASTM C 612, Type IVB, dual-density, semi-rigid mineral fiber board.
 - 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.
 - c. Combustibility, ASTM E136: Non-combustible.
 - 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 & MOISTURE 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 (AB-1).
- B. Related Sections
 - 1. Section 042000 - Unit Masonry: Coordinate compatibility with through-wall flashing.
 - 2. Section 076200 - Flashing and Sheet Metal.

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: Build mockups to set quality standards for materials and execution.

1. Build integrated mockups of exterior wall assembly, 150 sq. ft., incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - a. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
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.

1.6 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. (AB-1) 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.
 - e. Puncture Resistance, ASTM E 154: Minimum 40 lbf.
 - f. Water Absorption, ASTM D 570: Maximum 0.15 percent weight gain after 48-hour immersion at 70 deg F.
 2. Products and Manufacturers:
 - a. Perm-A-Barrier Wall Membrane by Grace Construction Products.
 - b. CCW-705 by Carlisle Coatings & Waterproofing.
 - c. PW 100/40 AVB by Protecto Wrap Company.
 - d. Sealtight 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.

2.4 **FLUID-APPLIED MOISTURE BARRIER S#7**

- A. (MB-4) Fluid-Applied, Vapor-Retarding Moisture Barrier: Elastomeric, modified bituminous or synthetic polymer (rubber) membrane; minimum dry film thickness of 40 mils.
 - 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: Maximum 0.10 perm.
 - c. Ultimate Elongation, ASTM D 412, Die C: Minimum 500 percent.
 - 2. Products and Manufacturers:
 - a. Elastomeric, Modified Bituminous Membrane:
 - 1) Air-Bloc 06 WB by Henry Company.
 - b. Synthetic Rubber Membrane:
 - 1) Air-Bloc, 21S, by Henry Company
 - 2) Perm-A-Barrier Liquid by Grace Construction Products.

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.
2. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.
3. Gypsum Sheathing: Fill joints greater than 1/4 inch with sealant according to ASTM C 1193 and air-barrier manufacturer's written instructions. Apply first layer of fluid air-barrier material at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air-barrier material over joint reinforcing strip.

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. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- C. 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..
- D. 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-surfaced 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 INSTALLATION OF FLUID-APPLIED MEMBRANE

- A. General: Apply fluid-applied moisture barrier in accordance with manufacturer's written instructions to achieve a continuous unbroken air-barrier membrane.
 - 1. Mask off adjoining surfaces not covered by barrier to prevent spillage and overspray affecting other construction.
 - 2. Apply fluid barrier material within manufacturer's recommended application temperature ranges.
 - 3. Apply to dry film thickness in accordance with manufacturer's instructions.
- B. Membrane Air Barriers: Apply a to substrates according to the following thickness. Apply in full contact around protrusions such as masonry ties.

- C. Apply strip and transition strip a minimum of 1 inch onto cured air-barrier material or strip and transition strip over cured air-barrier material overlapping 3 inches onto each surface according to air-barrier manufacturer's written instructions.
- D. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.
- E. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.6 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.

3.7 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. (MP-1) Flush Formed Aluminum Plate Panels.
 - 2. (MP-2) Formed Box-Rib-Profile Panels.
 - 3. (MP-4) Flush Formed Aluminum Sheet Panels.
 - 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.
- D. Calculations: Upon request from the Architect/Engineer only, Contractor shall submit calculations in accordance with Section 013300 – Submittal Procedures.
- E. Samples:
 - 1. 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:
 - a. Dead Loads, Live Loads, and Other Project Loads: As indicated on Construction Documents.
 - 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 CUSTOM FORMED METAL PANELS

- A. Single Source Responsibility: Provide metal panel products by a single firm for each type of metal panel.
- B. (MP-1) Flush Formed Aluminum Plate Panels: Custom-fabricated 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.
 - 1. Panel Profile: Flush profile as shown on Drawings.
 - 2. Panel Depth: As shown.
 - 3. Panel Sizes: Varying, as shown.
 - 4. Aluminum Sheet: 0.125 inch thick, tension-leveled, smooth aluminum sheet, ASTM B 209.
 - 5. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: Black, as selected by Architect.
 - 6. Panel Sizes: Varying, as shown.
- C. (MP-2) 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.
 - 1. Basis of Design: Morin Matrix Series, MX 1.0.
 - 2. Aluminum Sheet: 0.063 inch thick, tension-leveled, smooth aluminum sheet, ASTM B 209.
 - 3. Panel Configuration:
 - a. Profiles: Multiple, as selected by Architect from Manufacturer's full range.
 - b. Panel Width and Length: As shown.
 - c. Panel Depth: 1-1/2 inch.
 - d. Rib Orientation: As shown.
 - 4. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: Black, as selected by Architect.
- D. (MP-4) Flush Formed Aluminum Sheet Panels: Custom-fabricated formed aluminum sheet panels fabricated from single sheets of aluminum formed into profile for installation method indicated. Include attachment assembly components and accessories.
 - 1. Panel Profile: Flush profile as shown on Drawings.
 - 2. Panel Depth: As shown.
 - 3. Panel Sizes: Varying, as shown.
 - 4. Aluminum Sheet: 0.063 inch thick, tension-leveled, smooth aluminum sheet, ASTM B 209.
 - 5. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: Black, as selected by Architect.

2.3 PANEL 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 polyisobutylene 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.
 - 3. Lap Sealant: Butyl-rubber-based, ASTM C 1311.

2.4 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.
 - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - 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.

2.5 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. Commence metal panel installation and install in presence of factory-authorized representative.
 2. Shim or otherwise plumb substrates receiving metal wall panels.
 3. 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.

4. Install screw fasteners in predrilled holes.
 5. Locate and space fastenings in uniform vertical and horizontal alignment.
 6. Install flashing and trim as metal wall panel work proceeds.
 7. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 8. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
 9. 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.
 10. 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

SECTION 075400 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

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 2 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.
 - 4. GenFlex Roofing Systems.
 - 5. Johns Manville Roofing Systems
 - 6. Stevens Roofing Systems; Division of JPS Elastomerics.
 - 7. Versico Incorporated.
 - 8. Mule-Hide Products, Co..
- D. System Basis of Design: Sure-Weld TPO Fully-Adhered System by Carlisle Syntec.
- E. Roofing System Configurations: As indicated in Drawings and as follows:
 - 1. TPO-1: On concrete deck.
 - a. insulation,
 - b. protection board
 - c. adhered, reinforced TPO membrane, 60 mils (minimum), white;
 - 2. TPO-2: On metal deck
 - a. substrate board and vapor barrier
 - b. insulation,
 - c. protection board
 - d. adhered, reinforced TPO membrane, 60 mils (minimum), white;

2.3 ROOFING SYSTEM COMPONENTS

- A. Fleece-Backed Fabric-Reinforced Thermoplastic Polyolefin (TPO) Sheet: ASTM D 6878, internally fabric or scrim reinforced, fabric-backed TPO sheet.
 - 1. Membrane Thickness: 115 mils total, consisting of 60 mil TPO membrane and 55 mils fabric backing.
 - 2. Exposed Face Color: White, as selected by Architect.
- B. Rib Profiles: Sure-Weld TPO Contour Rib Profile by Carlisle Syntec.
- C. Cover (Protection) and Substrate Board: ASTM C 1177, glass-mat, water-resistant gypsum substrate, 1/2 inch thick.
 - 1. Product: Dens Deck by Georgia-Pacific Corporation.

- D. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
 - 1. Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.
 - 2. Roof Insulation: Provide preformed roof insulation boards manufactured or approved by TPO membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.
 - a. Average R-value: R-45 for roof insulation.
 - 3. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.
 - 4. Insulation Accessories: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
 - a. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
 - b. 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.
- E. Vapor Barrier at Roof: ASTM D 1970 vapor barrier; 40 mils thick self-adhering composite sheet consisting of rubberized asphalt and woven polypropylene film; water-vapor transmission of no more than 0.10 perms when tested in accordance with ASTM E 96.
 - 1. Basis of Design: VapAir Seal 725TR by Carlisle Syntec Systems, or as recommended by Roofing Manufacturer.

2.4 AUXILIARY MEMBRANE ROOFING MATERIALS

- A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
 - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's standard unreinforced thermoplastic polyolefin sheet flashing, 55 mils thick, minimum, of same color as sheet membrane.
- C. Bonding Adhesive: Manufacturer's standard.
- D. Slip Sheet: Manufacturer's standard, of thickness required for application.
- E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- F. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, prepunched.
- G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
- H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
 - 1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.

3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking."
4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
6. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system 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.
- C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- D. Install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Decking," according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry.

3.3 SUBSTRATE BOARD

- A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
 1. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

3.4 VAPOR BARRIER INSTALLATION

- A. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches and 6 inches, respectively. Bond vapor retarder to substrate as follows:
 1. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
 2. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

3.5 INSULATION INSTALLATION

- A. General: Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
 1. Install insulation adhesively or mechanically as recommended in writing by roofing system Manufacturer.
 2. Install tapered insulation under area of roofing to conform to slopes indicated.
 3. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
 - a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
 4. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
 5. Install with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.

6. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- B. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
 1. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. and allow primer to dry.
 2. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 3. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
 - C. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 1. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
 - D. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 1. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
 2. Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 3. Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
 - E. 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. Loosely butt cover boards together and fasten to roof deck as recommended in writing by roofing system Manufacturer.
 1. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

3.6 ADHERED MEMBRANE ROOFING INSTALLATION

- A. Base Flashing: Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
 1. 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.
 2. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
 3. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
 4. Terminate and seal top of sheet flashings[and mechanically anchor to substrate through termination bars.
- B. Adhere membrane roofing over area to receive roofing and install according to membrane roofing system manufacturer's written instructions.
- C. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
- D. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- E. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
- F. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.
- G. Apply membrane roofing with side laps shingled with slope of roof deck where possible.

- H. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions 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 sheet membrane.
 - 2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
 - 3. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
- I. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
- J. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weather-tightness of transition[**and to not void warranty for existing membrane roofing system**].

3.7 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
- C. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
- D. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.9 PROTECTING AND CLEANING

- A. Protect membrane 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. Flexible membrane flashing (MEMB FLASH).

1.2 COORDINATION

- A. Coordinate with Section 074200- Metal Panels for copings 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.
 6. Galvanic action between sheet metal and dissimilar materials.

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) Aluminum Sheet Flashing: ASTM B 209, with smooth and flat surface, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
1. Thickness: 0.040 inch.
 2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: Black, as selected by Architect.
 3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.
 4. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.

2.3 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.
1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F or higher.
 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.

2.4 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.

2.5 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 077233 ROOF HATCHES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Prefabricated roof hatches and accessories for ships' 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. Bilco Company.
 - 2. Milcor Incorporated
 - 3. Wasco Products
 - 4. Dur-Red Products
 - 5. J.L. Industries
 - 6. Nystrom Products.
 - 7. Babcock-Davis.

2.3 ROOF HATCHES

- A. (RH-1) Thermally-Broken Roof Hatch for Ships' Ladder Access: Pre-assembled, single-leaf aluminum roof-hatch units with thermally-separated lids and insulated curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, and integrally formed deck-mounting flange at perimeter bottom.
 - 1. Basis of Design: Type S-50TB by Bilco Company.
 - 2. Size: 30 inches by 96 inches.
 - 3. Modifications for Acoustic Performance: Provide continuous sound-seal gasket at cover perimeter.
- B. Cover: Shall be 11 gauge aluminum with a 5" 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.

1. Cover insulation: Shall be 3" thick polyisocyanurate with an R-value = 18, fully covered and protected by an 18 gauge aluminum liner.
 2. Reinforced to support minimum live load of 40 psf with maximum deflection of 1/150th of the span or 20 psf wind uplift.
 3. Cover operation shall not be affected by temperature.
- C. Curb: Minimum height above roof membrane 12-inches, fabricated of 11 gauge 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" flange with 7/16" holes provided for securing to the roof deck.
1. Equipped with an integral metal cap flashing of the same gage and material as the curb, fully welded at the corners, with flashing system, including stamped tabs, 6 inch on center, to be bent inward to hold roofing membrane securely in place.
 2. Curb Insulation: 3-inches polyisocyanurate, R-value of 18.
- D. Lifting mechanisms: Manufacturer's compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout entire arc of opening and closing. Lower tube shall interlock with flanged support shoe.
- E. Hardware:
1. Hinges: Heavy pintle type.
 2. Cover: Equipped with a spring latch with interior and exterior turn handles.
 3. Roof scuttle: Equipped with interior and exterior padlock hasps.
 4. Latch strike: Stamped component bolted to the curb assembly.
 5. Cover: Automatically lock in the open position with a rigid hold open arm equipped with a 1 inch diameter red vinyl grip handle to permit easy release for closing. Bolted into heavy gage channel reinforcing welded to the underside of the cover and concealed within the insulation space.
 6. Compression spring tubes: Constructed of anti-corrosive composite material.
 7. Other hardware: Zinc plated and chromate sealed.
 8. Springs: Electrocoated acrylic finish for corrosion resistance.
- F. Finishes: Factory finish alkyd based red oxide primed steel. Refer to Section 099000 - Painting for painted finish.

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 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: For roof accessories. 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.

1.3 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.
- 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.

1.4 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.

1.5 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane, base flashing and with 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.
- D. Coordinate features of motors, installed units, and accessory devices and features 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.

1.6 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.
 - 1. State services, obligations, conditions, and terms for agreement period and for future renewal options.
 - 2. Proposed maintenance agreement shall include _____, performed on schedule as recommended by supplier/installer.
 - 3. Maintenance Period: ____ years.

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.
 - 1. Covers shall be reinforced to support a minimum live load of 40 psf (195 kg/m²) with a maximum deflection of 1/150th of the span or 90 psf (439 kg/m²) wind uplift.
 - 2. Entire smoke vent shall be weathertight with fully welded corner joints on cover and curb.
 - 3. Sound Transmission Rating: Minimum STC-45 sound rating.
- 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 45, and with energy average over the 1/3 octave band center frequencies as follows:

Minimum Sound Transmission Loss (dB re 20 µPa) at Octave Band Center Frequency, Hz					
125	250	500	1000	2000	4000
28	39	42	43	46	51
 - 2. Outdoor-Indoor Transmission Class (OITC) Rating per ASTM E1332: OITC 37.
- D. Acoustical fire vents shall provide laboratory measured acoustic performance as follows:

Sound Transmission Class Rating	Minimum Sound Transmission Loss (dB re 20 μ Pa) at Octave Band Center Frequency ¹ , Hz					
	125	250	500	1000	2000	4000
STC 45	28	39	42	43	46	51

Note: 1. Energy average over the 1/3 octave band center frequencies.

- E. Sound Transmission Class (STC) ratings shall tested in accordance with latest version of ASTM-E90 and be determined according to ASTM E 413.
- F. 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.
- G. FM - Factory Mutual Research, as applicable to smoke vents.
- H. Source Limitations: Obtain steel acoustic smoke vent assemblies, including lids, curbs, sound control seals, hardware and other components from single source from single manufacturer.

2.2 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. Babcock-Davis.
 - 2. Bilco Company.
 - 3. Milcor Incorporated.
 - 4. Nystrom Building Products.
 - 5. Wasco Products.

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.
 - 1. Basis of Design: Provide one of the following products for all smoke vents, with electric motor operating system as recommended by smoke vent Manufacturer.
 - a. Model ACDSH by Bilco Company.
 - b. Model U-LP by Milcor Inc..
 - 2. Size: 60 inches by 96 inches.
 - 3. Acoustic Rating: STC Rating 46 per ASTM E 413 and OITC (Outdoor-Indoor Transmission Class) rating of OITC 37 as tested in accordance with ASTM Standard E 1332.
 - 4. 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.
 - 5. Loads: Minimum 40-lbf/sq. ft. external live load and 30-lbf/sq. ft. internal uplift load.

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.
- H. *Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.*
1. *Height: **42 inches** above finished roof deck.*
 2. *Posts and Rails: Galvanized-steel pipe, 1-1/4 inches in diameter or galvanized-steel tube, 1-5/8 inches in diameter.*
 3. *Flat Bar: Galvanized steel, 2 inches high by 3/8 inch thick.*
 4. *Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.*
 5. *Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.*
 6. *Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.*
 7. *Fabricate joints exposed to weather to be watertight.*
 8. *Fasteners: Manufacturer's standard, finished to match railing system.*
 9. *Finish: [Manufacturer's standard]*
 - a. *Color: As selected by Architect from manufacturer's full range.*

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 078100 APPLIED FIREPROOFING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Wet-mix sprayed fireproofing (FP-1).

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. (FP-1) 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 Carbolite 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 PENETRATION 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 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.
- C. Submit installer qualifications for each person installing firestopping systems.

1.3 QUALITY ASSURANCE

- A. Installer's 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. 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.
- C. 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.
- D. 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."

1.4 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.

1.5 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.

1.6 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.

1.7 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. 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 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.
- B. 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.
- C. Refer to Schedule at the end of this section.
- D. 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.
- E. 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.
 3. Substrate primers.
 4. Collars.
 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:

<p>Warning – Fire-stop System DO NOT DISTURB Notify Building Management of Any Damage</p> <p>Manufacturer's System No. _____ UL System No: _____ Contractor: _____ Date Installed: _____ Manufacturer: _____</p>

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

Fire Stopping Systems

UL Classification System

		Construction Penetrated	Type Of Construction	System Identification
1	No Penetrating Items:	F, W, C	A, B, J, K, L	0001-0999
2	Metallic Pipes, Conduit or Tubing:	F, W, C	A, B, J, K, L	1001-1999
3	Nonmetallic Pipe, Conduit or Tubing:	F, W, C	A, B, J, K, L	2001-2999
4	Electric Cables:	F, W, C	A, B, J, K, L	3001-3999
5	Cable, Trays with Electric Cables:	F, W, C	A, B, J, K, L	4001-4999
6	Insulated Pipes:	F, W, C	A, B, J, K, L	5001-5999
7	Electrical Bussduct Penetrations:	F, W, C	A, B, J, K, L	6001-6999
8	Mechanical Ductwork Penetrations:	F, W, C	A, B, J, K, L	7001-7999
9	Multiple Penetrations Through Common Openings:	F, W, C	A, B, J, K, L	8000-8999

Construction Penetration

F	Floor penetration
W	Wall penetration
C	Either Wall or Floor Penetration

Type of Construction

A-	Concrete floors equal to or less than 5-inches thick
B-	Concrete floors greater than 5-inches thick
J-	Concrete or masonry walls equal to or less than 8-inches thick
K-	Concrete or masonry walls greater than 8-inches thick
L-	Framed walls

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.
 - 3. Joints between perimeter edge of fire-resistance-rated floor assemblies and back of non-fire-resistance-rated, exterior, glazed aluminum curtain walls.

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.
 2. Joint System: Utilizing 4 PCF mineral wool and non-hardening firestop sealant.
- 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. .
 2. Product: CP-606 Flexible Firestop Sealant by Hilti.
 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 (FGS-1).
 - 2. Preformed extruded-silicone joint seals (FGS-2).
- 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. (FGS-1) Preformed Foam Joint Sealant: 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.; Sealite or Sealite 50N.

- e. Willseal USA, LLC; [Willseal 150 or Willseal 250.
- D. (FGS-2) Preformed Extruded Silicone Joint Sealants: 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.
 - c. May National Associates, Inc.; Bondaflex Silbridge 300.
 - 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:
 - 3. Statement of qualification for manufacturers and installers.
 - 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 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.

1.6 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 weather-proofing 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. (SLNT-1) 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:
 - a. Sika Chemical Corporation: Sikaflex-1a.
 - b. BASF Building Systems: Sonolastic NP-1.
 - c. Tremco Incorporated: Dymonic.
 - d. Pecora Corporation: Dynatrol I.
 - e. Tremco Incorporated: Vulkem 116.
- B. (SLNT-2) 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:
 - a. Tremco Incorporated: THC900.
 - b. BASF Building Systems: Sonolastic SL-2.
 - c. Pecora Corporation: Urexpan NR-200.

2.3 SILICONE SEALANT

- A. (SLNT-3) 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:
 - a. General Electric: Silpruf SCS 2000.
 - 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. (SLNT-4) 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:
 - a. General Electric: Silpruf SCS 2000.
 - b. Dow Corning Corporation: 756 Building Sealant.
 - c. Tremco Construction Division: Spectrem 2.
- C. (SLNT-5) 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:
 - a. Dow Corning Corporation: 790 Building Sealant.
 - b. Tremco Construction Division: Spectrem 1.
- D. (SLNT-6) 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
 2. Application: Adhering joint dowel pins at stonework.
- E. (SLNT-8) 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.
 4. Laticrete International, Inc.; Latasil Tile & Stone Sealant.
 5. Pecora Corporation; Pecora 898 Sanitary Silicone Sealant.
 6. Tremco Incorporated; Tremsil 600 White.
- F. (SLNT-9) Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT; field-tintable; non-staining.
1. Field-Tinted: Provide at locations as directed by Architect.
 - a. Basis of Design: Pecora Corporation; 890FTS.
 - b. Color: As selected by Architect to match masonry mortar joints.
 2. Field-Tinted and Textured: Provide at locations as directed by Architect.
 - a. Basis of Design: Pecora Corporation; 890FTS-TXTR.
 - b. Color: As selected by Architect to match masonry mortar joints.

2.4 ACRYLIC SEALANT

- A. (SLNT-7) 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.
- c. Pecora Corporation: AC-20.

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 FIELD QUALITY CONTROL

- A. Sealant Adhesion Field Test: Comply with following.
 - 1. Weathering Sealant Adhesion: After liquid-applied sealant is fully cured, perform sealant adhesion test according to sealant manufacturer's recommendations.

3.5 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.

3.6 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-precaster architectural concrete paving units.
 - 3) Joints in stone paving units, including steps (where applicable).
 - 4) Tile control and expansion joints.
 - 5) Joints between different materials listed above.
 - 6) Other joints as indicated.
 - b. (SLNT-2): 2-Part polyurethane sealant, self-leveling, traffic grade, Class 25 .
2. Horizontal Surfaces Subject to Traffic and Water Immersion:
 - a. (SLNT-): 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. (SLNT-3): Silicone single component, nonsag, neutral curing, Class 25
 - c. (SLNT-4): Silicone multicomponent, nonsag, neutral curing.
4. Perimeter joints between materials listed above and frames of doors, windows, and louvers:
 - a. (SLNT-4): 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. (SLNT-5) Silicone Ultra Low-Modulus Silicone Rubber Sealant.
6. Vertical Surfaces and Horizontal Surfaces Not Subject to Traffic:
 - a. Joint Locations:
 - 1) Stone to Stone
 - 2) Stone to Masonry
 - 3) Cast Stone to Cast Stone
 - 4) Stone to Cast Stone
 - b. (SLNT-9): Silicone Single-Component, Nonsag, Neutral-Curing.

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. (SLNT-2): 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-precaster structural concrete units.

- g. Other joints as indicated.
- 3. Mildew-Resistant Sealant: Mildew resistant, single component, nonsag, neutral curing, Silicone.
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated.
- 4. Acoustic Joint Sealant: Acoustical. Refer to Section 092900 for acoustic sealant in gypsum board assemblies.

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.
 - 7. Fire-resistance ratings.

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:
 - 1. Construction Specialties Group.
 - 2. MM Systems Corporation
 - 3. Balco Inc.
 - 4. Watson-Bowman-Acme Corporation
 - 5. Pawling Corporation
 - 6. Michael Rizza Company, Inc.
 - 7. Nystroms, Inc.
 - 8. InPro Corporation

2.3 EXPANSION JOINT SCHEDULE

- A. Exterior Joints: 2-inch joint width.
 - 1. EXP JT-___: Exterior, wall-to-wall, perpendicular
 - 2. EXP JT-___: Exterior, roof-to-wall
- B. Interior Joints: 2-inch joint width.
 - 1. EXP JT-___: Interior, floor-to-floor
 - 2. EXP JT-___: Interior, ceiling-to-ceiling
 - 3. EXP JT-___: Interior, wall-to-wall, abutted
 - 4. EXP JT-___: Interior, wall-to-wall, perpendicular

2.4 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.

2.5 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.

2.6 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.

2.7 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 & FRAMES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Pressed steel hollow metal doors and frames.
 2. Fire-rated hollow metal doors and frames.
 3. Hollow metal glazed openings, and other hollow metal frames for glass.
 4. Rough bucks, frame reinforcing, door reinforcing, door insulation, closure panels, clip angles and anchorage.
 5. Factory prime paint finish.

1.2 COORDINATION

- A. Anchorages: 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.
- B. Preparation for Hardware: Reinforced and machine hollow metal work for hardware specified in Sections 087100 and automatic door operators 087113.
1. Obtain templates, shop drawings, jigs, or materials, and a copy of the accepted Hardware Schedule from the hardware distributor.
 2. Templates: 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.
 3. Reinforcing: Reinforce the work of this Section to meet requirements for anchoring hardware using concealed fasteners.
- C. Existing Openings: Where new components are scheduled for application to existing openings or where modifications to existing doors and frames is required, field verify existing conditions by field measurements prior to ordering any material. Coordinate installation of frames, doors and door hardware to suit opening conditions and to provide for proper operation.
1. Contractor shall carefully protect existing doors, frames and hardware for all existing openings that will remain in the project.
 - a. Any material that is damaged or lost shall be replaced to match the existing similar items at no additional cost to the owner.
 - b. Doors and frames that are to be re-used shall be removed safely and stored in a secured area until re-installed at selected openings.
 - c. Coordinate with owner for any additional existing doors and/or frames that were removed and not used that they may want to be turned over to the owner with all operating parts and fasteners in working condition.
 - d. Any material that is ordered, and/or fabricated and will not fit into existing openings and is required for the intended use, such material shall be removed and replaced at no additional cost to the owner.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.
- B. Shop Drawings: Include the following:
1. Elevations of each door type.
 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 each different wall opening condition.
 6. Details of anchorages, joints, field splices, and connections.

- 7. Details of accessories.
 - 8. Details of moldings, removable stops, and glazing.
 - 9. Details of conduit and preparations for power, signal, and control systems.
- C. Schedule: Provide a schedule, in electronic PDF format, of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly, for tests performed by a qualified testing agency.
- B. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented 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 vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.
- D. Handle hollow metal with care to prevent damage to hollow metal and to factory-applied primer and galvanized coatings.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. 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 and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 (neutral pressure at 40" above sill) 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. Provide smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.
 - 2. Oversize Fire-Rated Door Assemblies: For door assemblies required to be fire-rated and exceeding sizes of tested assemblies, provide certificate or label from approved independent testing and inspection agency, indicating that door and frame assembly conforms to requirements of design, materials and construction as established by individual listings for tested assemblies.
 - 3. Temperature Rise Rating: At stair enclosures, provide doors with Temperature Rise Rating of 450 degrees F maximum in 30 minutes of fire exposure.
- B. 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.

2.2 HOLLOW METAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ceco Door Products; an Assa Abloy Group company.
 - 2. Curries Company; an Assa Abloy Group company.
 - 3. Steelcraft; an Ingersoll-Rand company.

- B. Cold Rolled Steel Sheets: Cold formed, prime quality pickled, annealed stretcher level steel, free from scale, pitting or other surface defects, complying with ASTM A366.
- C. Galvanized Steel Sheets: ASTM A526 or A527, G60 zinc coating. Use galvanized steel sheets for exterior hollow metal doors, door frames and door louvers.
- D. Minimum gages of hollow metal are specified below. Provide heavier gage if required by details or specific condition. Entire frame and sidelight shall be of same gage.
 - 1. 14 gage: Exterior door frames, transom and sidelight frames.
 - 2. 16 gage: Exterior doors.
 - 3. 16 gage: Interior door frames, and glazed opening frames.
 - 4. 16 gage: Labeled frames (or heavier if required by label).
 - 5. 16 gage: Interior doors (or heavier if required by label).
 - 6. 16 gage: Trim members.

2.3 RELATED MATERIALS

- A. Steel Reinforcing: ASTM A36.
- B. Door Bumpers or Silencers: GJ-64.

2.4 HOLLOW METAL FRAMES

- A. General: Provide full profile welded frames, unless otherwise indicated. Where necessary, alternate details will be considered provided design intent is maintained. Consider and provide for erection methods. Refer to Openings Schedule for frame dimensions.
- B. Typical Reinforcing: Provide minimum hinge reinforcement 3/16 inch by 1-1/2 inch by 9 inch and lock strike reinforcement 3/16 inch by 1-1/2 inch by 4 inch long. Provide similar reinforcement for hardware items as required to adequately withstand stresses, minimum 12 gage, including channel reinforcement for door closers and closer arms, door holders and similar items. Provide reinforcement and clearances for concealed in-head bar closers and for mortise locks.
- C. Cover Plates: For hinge and strike plate cutouts, provide fully enclosed pressed steel cover boxes spot welded to frames behind mortises.
- D. Hardware: Mortise, reinforce, drill and tap for mortise hardware, except drilling and tapping for surface door closers, door closer brackets and adjusters shall be done in field.
- E. Anchorage: Provide standard and special anchorage items as required. Provide 12 gage angle clips at bottom of frames with punched holes for securing frames to floor, except where frames are secured entirely by rough bucks. Provide formed steel channel spreader at bottom of frames, removable without damaging frame. At masonry, provide anchors (about 2 inch by 10 inch) approximately 24 inches on center.
- F. Silencers: Provide specified silencers, except where stop does not occur and at smoke gasketed openings, 3 per jamb at single door and one for each door at double doors. Do not provide silencers on doors with sound gasketing.
- G. Extensions: Reinforce transom bars or mullions as necessary to provide rigid installation. Where required (as at multiple openings) to stabilize large frames, provide frame or mullion extensions to anchor to structure above, proper size to fit within overhead construction. Provide angle clips to fasten to structure.
- H. Mullions: Provide mullions, continuously reinforced, straight and without twist, of tubular design. For removable mullions provide fastenings of non-ferrous bolts at bottom, with sleeves at head of frame for mullion to clip over.
- I. Clearances: Provide and be responsible for proper clearances at metal frames, including for weatherstripping, soundstripping and smoke gasketing. Glass clearance shall be thickness of glass plus clearance each side (1/8 inch minimum exterior - 1/16 inch minimum interior), adjust for installation, glass thickness to allow for glazing and sealant. Where sealed double glazing is indicated, provide rebates minimum of 3/4 inch and provide 1/4 inch clearance at glass edges. Where units fit around concrete blocks (blocks built into frames) obtain actual dimensions of blocks being used to establish minimum clearances.

- J. Stops: Set with countersunk or Jackson head screws.
 - 1. Non-fire rated door frames scheduled to receive acoustical seals shall have a flat profile at the head and jamb, with the acoustical seals serving as stops. Fire rated frames shall utilize acoustical seals surface-mounted to the molded stops.
- K. Labeled Frames: Construct in accordance with requirements for labeled work. Attach proper U.L. label, Warnok Hersey. "B" labeled frames shall be 1-1/2 hour construction.
- L. Joinings: At frames with equal width jambs and head, neatly miter on face (except locations as at transom bars and at frames with large head members). Cope and butt stops. Weld length of entire joint, including face and flat intersections. Grind smooth, at other frames, provide same mitred joint wherever possible (at intersection of jamb-head or jamb-sill) and at other locations butt metal neatly and fully welded. All joints to be tight, neatly ground, puttied, and sanded smooth before priming.
- M. Workmanship: Fabricate so no grind marks, hollow or other out-of-plane areas are visible. At joints of intermediate members (as mullions and transom bars), provide tight joining, neatly accomplished without holes, burned out spots, weld build up or other defacing work. Fill to close cracks and to preserve shapes. Tightly fit loose stops, to hairline joints.
- N. Finish: Clean frames by degreasing process and apply thorough coating of baked-on primer, covering inside as well as outside surfaces. At galvanized frames, coat welds and other disrupted surface with zinc-rich paint containing not less than 90 percent zinc dust by weight.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
- B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:
 - 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
 - 2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.6 HOLLOW METAL DOORS

- A. Provide to design indicated including: Flush panel doors, flush panel with cut-out as indicated, stile and rail type, stile and rail with door louver. Use galvanized steel at exterior doors.
- B. Flush Doors: Reinforce, stiffen and sound deaden. Provide cut-outs for glass and louvers with stops as shown. Provide flush steel closure at top of exterior and interior doors and at bottom of exterior doors with drain holes in bottom closure. Provide seamless edge. Following door construction types are acceptable.
 - 1. Exterior Doors (and Interior Reinforced Doors): 16 gage steel stiffener reinforced vertically 6 inches o.c. full height and width, spot welded 5 inches o.c. to both face sheets. Stiffeners welded together top and bottom. Insulate with 2-1/2 lb density mineral wool insulation.
 - 2. Honeycomb Core Interior Doors (Typical): Impregnated Kraft honeycomb core completely filling inside of center panel and permanently laminated to inside face sheets.
 - 3. Door Construction: Manufacturer's standard honeycomb, polyurethane foamed in place, unitized steel grid, vertical steel stiffeners, or rigid mineral fiber core with internal sound deadener on inside of face sheets where appropriate in accordance with SDI standards.
- C. Stile and Rail Doors: Construct with equivalent reinforcing. Reinforce intersections of stiles and rails at stile type doors, to form rigid unit capable of withstanding severe abuse without racking or sagging.
- D. Labeled Doors: Insulate as required by Underwriters Laboratories. Build in special hardware and provide astragals as indicated. At one hour and at 1-1/2 hour doors at enclosures, maximum transmitted temperature end point shall not exceed 450 degrees F above ambient at end of 30 minutes of fire exposure specified in NFPA 252 and UL10 ABC as applicable.

- E. Seamless Vertical Edges: Construct doors with smooth flush surfaces, without visible joints or seams on exposed faces or stile edges. Interior and exterior door edge seams shall be full welded, except if polyurethane core is used for exterior, these doors shall have edges filled with body putty and ground smooth.
- F. Typical Reinforcement: Provide as required for hardware items. For lock reinforcement, provide manufacturer's standard reinforcement. Provide 12 gage reinforcement for escutcheons or roses. centering clips to hold lock case in alignment. For door checks, provide 3/16 inch channel type reinforcements, 3-1/2 inch deep by 14 inches long, or as required. Hinge reinforcement minimum 7 gage by 1-1/2 inch by 9 inch bar. Weld reinforcing to door. Reinforce doors for surface items such as surface and semi-concealed closers, brackets, surface holders and door stops. Drilling and tapping installation of these surface items shall be done in field by hardware installer.
- G. Special Reinforcing: At exterior doors, reinforce inside of door on hinge side with high frequency hinge preparation. Weld to door.
- H. Hardware: Mortise, reinforce, drill and tap for hardware furnished under Section 087000 - Hardware, except drilling and tapping for surface door closers, door closer brackets and adjusters shall be done in field. Obtain templates from hardware supplier.
- I. Finish: Provide prime coat finish on doors. Thoroughly clean off rust, grease and other impurities. Grind welds smooth, no marks shall show. Apply metallic filler as required to fill cracks and joints and to level any weld areas or similar imperfections. Sand filler coat smooth.
- J. Hollow Metal Panels: Same materials and constructed and finished in same way as specified for hollow metal doors.

2.7 FASTENINGS

- A. Provide fastenings, anchors and clips as required to secure hollow metal work in place. Provide Jackson head screws, or flatter. Dimple metal work to receive screw heads. Set stops and other non-structural fastenings with #6 Jackson head self-tapping screws.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine supporting structure and conditions under which hollow metal is to be installed. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install hollow metal in accordance with reviewed shop drawings and manufacturer's printed instructions. Securely fasten and anchor work in place without twists, warps, bulges or other unsatisfactory or defacing workmanship. Set hollow metal plumb, level, square to proper elevations, true to line and eye. Set clips and other anchors with Ramset "shot" anchors or drill in anchors as approved. Units and trim shall be fastened tightly together, with neat, uniform and tight joints.
- B. Placing Frames: Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders leaving surfaces smooth and undamaged.
 1. At acoustic rated metal stud and gypsum board partitions, install insulation within frames.
 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
 3. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame 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. Provide adjustable wedged or bolted anchorage to frame jamb members.
 4. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

- b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
- C. Place fire-rated frames in accordance with NFPA Standard #80.
- D. Door Installation: Fit hollow metal doors accurately in their respective frames, within following clearances: Jambs and head 3/32 inch, meeting edges pair of doors 1/8 inch, sill where no threshold or carpet 1/4 inch above finished floor, sill at threshold 3/4 inch maximum above finished floor, sill at carpet 1/4 inch above carpet. Place fire-rated doors with clearances as specified in NFPA Standard #80.
- 1. Provide undercut no greater than 3/8-inch at doors equipped with automatic sound seal door bottoms.

3.3 ADJUSTING AND CLEANING

- A. Prime Coat Touch-Up: Immediately after installation, sand smooth rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.
- B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION

SECTION 081400 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.
- B. Related Sections:
 - 1. Section 064000 - Architectural Woodwork: Wood veneer (WD-1).
 - 2. Section 081113 - Hollow Metal Doors and Frames.
 - 3. Section 087100 - Door Hardware.
 - 4. Section 088000 - Glazing: Glass and glazing for doors.
 - 5. Section 099000 - Painting: Painted finish.

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.
- C. Sustainability Submittals: Submit required product data and documentation in accordance with Section 018113 - Sustainable Design Requirements and Section 013300 - Submittal Procedures:
 - 1. Product Data for LEED MRc 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
 - 2. Certificates for LEED MRc 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body. Include statement indicating costs for each certified wood product.
 - 3. Product Data for LEED EQc 4.1: For adhesives and sealants used inside the weatherproofing system, including printed statement of VOC content.
 - 4. Product Data for LEED EQc 4.4: For composite wood and agrifiber, including printed statement of VOC content.

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 Limitations: 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:
 - 1. Temperature Range: Between 60 and 90 deg F.
 - 2. Relative Humidity Range: Between 25 and 55 percent.
- B. Monitor, Record and 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.
 - 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

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. Forest Certification: Provide doors made with cores and veneers of wood products obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
 - 2. Low-Emitting Adhesives and Binders: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
 - 3. 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. Eggers Industries
 - 2. Marshfield Door Systems
 - 3. Algoma Group
- E. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.
- F. Structural-Composite-Lumber-Core for Non-Fire-Rated Doors: WDMA I.S.10.
 - 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.
 - 1. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings 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.

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: (WD-1), as specified in Section 064000 - Architectural Woodwork.
 - 2. Veneer Matching:
 - a. Match between Veneer Leaves: Book match.
 - 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. Sheen: Matching Architect's sample.
- 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 ACCESSORIES

- A. 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.
- B. 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.

2.5 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.
 - 3. Slightly ease vertical edges.

- 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: For installation, refer to Section 087100 - Door Hardware.
- B. Installation Instructions: 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 083100 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 PERFORMANCEREQUIREMENTS

- 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. Acudor Products Inc.
 2. Babcock-Davis
 3. Balco
 4. Cesco Access Products
 5. J.L. Industries
 6. Karp Associates Inc.
 7. Milcor Inc.
 8. Nystrom Building Products
 9. Williams Brothers Corporation of America

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-3) 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.
- D. (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.
- E. 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 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 PERFORMANCE REQUIREMENTS

- A. 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 as close to neutral pressure as possible according to NFPA 252 or UL 10B.
 - 1. Smoke Control: Provide doors that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. of door opening at 0.10-inch wg for both ambient and elevated temperature tests.
- B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of federal, state and municipal authorities having jurisdiction.

2.2 PRODUCTS AND MANUFACTURERS

- 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. Metro Door.
5. Overhead Door Corporation.
6. Raynor.

2.3 COILING DOOR

- A. (CD-1) and (CD-2) Insulated, Motor-Operated, Overhead Coiling Door:
 1. Products and Manufacturers:
 - a. Thermiser Insulated Door Model ESD20 by Cornell Iron Works.
 - b. Type FMWI by Cookson Company.
 2. Aluminum Door Curtain Slats: ASTM B 209 sheet or ASTM B 221 extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of 0.050 inch; and as required.
 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, custom color matching color (PT) as shown on Door and Frame Schedule on Sheet A080.
 - a. Hot dipped galvanized G-90 coating consistent with ASTM A-653.
 - 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.
 7. Electric Door Operator:
 - a. Operator Location: Top of hood.
 - b. Motor Exposure: Interior.
 - c. Emergency Manual Operation: Push-up type.
 - d. Obstruction-Detection Device: Automatic photoelectric sensor; self-monitoring type.
 - 1) Sensor Edge Bulb Color: As selected by Architect from manufacturer's full range.

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.
 - 6. Each different wall opening condition.
 - 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. Acoustical Door by Wenger Corporation / JR Clancy.
 - 3. Noise-Lock by IAC Acoustics.

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.
 - 7. Ceiling Struts: Minimum 3/8-inch-thick by 2-inch- wide uncoated steel unless otherwise indicated.
 - 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 door 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-mildry 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.
 3. Metal-Stud Partitions: Fully fill frames with mineral-fiber insulation.
 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:
 - a. Jambs: 1/8 inch.
 - 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 prefit 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 083474 SOUND CONTROL SLIDING DOOR ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Pre-fabricated and factory-tested sound control door assemblies of single-leaf sliding/rolling doors, door frames, perimeter sealing devices, door hardware and accessories (SCDA-____).
 - 1. All components shall be supplied by the single manufacturer, and shall comply with the specified laboratory acoustical ratings as tabulated at end of this section.
 - 2. Door manufacturer's representative to be present during installation and final check-out by architect and acoustical consultant.
- B. Related Sections:
 - 1. Section 081113 - Hollow Metal Doors and Frames.
 - 2. Section 087100 - Door Hardware.
 - 3. Section 099000 - Painting: Finish painting.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Summary of forces and loads imposed on walls by sliding doors.
 - 2. Fire-Rated Doors: Include description of fire-release system including testing and resetting instructions.
 - 3. Oversized Special-Purpose Fire Door Assembly Certification: For door assemblies required to be fire rated and that exceed size limitations of labeled assemblies, signed by authorized representative of testing agency.
 - 4. Submit certified copies of 1/3 Octave Band Transmission Loss test data and STC rating as issued by an accredited independent acoustical laboratory. All testing shall be in accordance with ASTM E90 latest version.
 - 5. Field performance data tested by an independent laboratory or consultant, in accordance with ASTM E336, shall be submitted showing compliance with specified values
- B. Shop Drawings: Submit Shop Drawings for fabrication and installation of door panels, door frames, hardware, accessories, and acoustical seals. Shop drawings shall included detail assembly drawings, showing the complete installation, a listing of materials, surface finishes, fabricating assembly and installation tolerances. No Shop Drawing shall be submitted which shows details or components that deviate from those shown or described on Construction Documents. A request for deviations must be submitted in writing to Architect for review and approval.
- C. Submit letter of certification stating that partition framing is suitable for the installation and proper operation and performance of the door systems. Installation of doors constitutes acceptance of suitability of partition framing.
- D. Submit with proposal a Schedule indicating a comparison of the Acoustical Performance and hardware requirements of these Specifications with the Acoustical Performance and hardware offered in the proposal.

1.3 QUALITY ASSURANCE

- A. The manufacturer of Sound Control Door Assemblies shall have a minimum 5 years experience in the fabrication and installation of acoustically-rated door assemblies similar to those of this Section.
- B. Door manufacturer will be responsible for all details associated with the door and closure/locking and security systems hardware to achieve acoustical performance; including full perimeter of door and frame.

- C. 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.
- D. Certification of acoustical tests must be submitted by Contractor for approval prior to installation.
- E. The Contractor shall employ an organization and personnel who are trained and skilled mechanics with previous experience in the installation of similar precision fabricated assemblies.
- F. Fabrication shall not proceed until written approval of Submittal has been issued.
- G. 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.
- H. Manufacturer shall provide on-site instruction to Contractor for installation and review installation of each door to ensure field acoustic performance is achieved. Should field testing by Acoustic Consultant find doors to be deficient of field performance criteria, doors shall be remediated at no cost to the Owner.

1.4 ACOUSTICAL FIELD CERTIFICATION

- A. Contractor shall guarantee acoustical performance in the field of the Sound Retardant Steel Doors, as indicated in this Specification. The acoustical performance rating in the field shall not be less than a Noise Isolation Class (NIC) 2 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.
- B. 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.
- C. 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.

1.5 PRODUCT HANDLING

- A. Deliver hollow metal work crated to provide protection during job storage. Use all means necessary to protect the material of this Section before, during and after installation and to protect the installed work and materials of all other trades. Inspect for damage prior to installation. Minor cosmetic damage may be repaired on jobsite on approval; otherwise, replace damaged item. Frames and doors which arrive on site bent, warped, or otherwise unsuitable for installation and acoustic performance shall be rejected and complete replacement provided.

1.6 WARRANTY

- A. Upon completion of work of this Section, and as a condition of its acceptance, deliver to the Architect six copies of the manufacturer's standard written two-year warranty.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. 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 as close to neutral pressure as possible according to NFPA 252 and UL 10B.
 - 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

- 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.

2.2 SYSTEM DESCRIPTION

- A. Custom-Fabricated, STC-Rated, Oversized Rolling Panel Doors:
- B. Basis of Design:
 - 1. Noise Barriers
 - 2. Wenger Corporation/JR Clancy
 - 3. IAC Acoustics
- C. SCDA-10
 - 1. Acoustically-Rated: STC-50
 - 2. Manually-Operated
 - 3. Finish: PT.
- D. SCDA-11:
 - 1. Acoustically-Rated: STC-50
 - 2. Fire-Rated: 120 minutes
 - 3. Manually-Operated
 - 4. Finish: PT.

2.3 MATERIALS

- A. Steel Plate, Shapes, and Bars: ASTM A 36.
- B. Steel Sheets: ASTM A 1008, Commercial Steel (CS), or Drawing Steel (DS), Type B, cold rolled; exposed, matte finish.
- C. Metallic-Coated Steel Sheet: ASTM A 653, Commercial Steel (CS), Type B, with A90 zinc-iron-alloy (galvannealed) coating or G60 zinc coating; restricted flatness.
- D. Stainless-Steel Sheets: ASTM A 240, Type 304; stretcher-leveled standard of flatness; No. 4 finish.
- E. Hardware and Fasteners:
 - 1. Hot-dip galvanize according to ASTM A 153 where units are used on galvanized-steel exterior doors
 - 2. Stainless steel.

2.4 FABRICATION

- A. Fabricate sliding metal fire door assemblies rigid, neat in appearance, and free of defects, warp, or buckle. 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.
- B. Factory prepare sliding metal fire door assemblies and frames to receive hardware and accessories including cutouts, reinforcements, mortising, drilling, and tapping.

2.5 STEEL FINISHES

- A. Factory Prime Finish: Immediately after surface preparation and pretreatment, apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer.

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 floor under door to confirm that floor is level for the full travel of door.
2. Examine wall where track assembly mounts and area behind door to confirm that wall is smooth and in same plane for the full travel of door.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install sliding metal fire doors according to NFPA 80 and manufacturer's written instructions for type of door operation indicated and fire-protection rating required.

1. Interface fire-detection devices with building's fire-alarm system.

B. Drill necessary holes cleanly, with no broken areas or spalls, for installation of fasteners in concrete or masonry. Remove and replace damaged masonry as directed.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Test door closing when activated by detector or alarm-connected, fire-release system. Reset door-closing mechanism after successful test.
2. 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. Sliding metal fire door will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.4 ACOUSTICAL TESTING INSPECTION

A. The manufacturer's representative shall visit the site to make final adjustments to the door and acoustical seals as needed to ensure no acoustical leaks around the door assembly and through seal areas.

B. Field Certification: Vendor shall provide doors to meet acoustical performance of the products in the field. The minimum performance rating of each door shall be as follows:

Door Acoustical Performance		
Door	Laboratory Ratings (ASTM E90)	Field Ratings (ASTM E336)
	STC ⁽¹⁾	NIC ⁽³⁾
	51	49

⁽¹⁾Sound Transmission Class

⁽²⁾Transmission Loss

⁽³⁾Noise Isolation Class

⁽⁴⁾Noise Reduction

⁽⁵⁾Tested nominally 5 feet from each side of door.

C. Field tests to be conducted by the manufacturer's representative to verify acoustical performance. Field tests to be conducted in accordance with E336 for Noise Reduction.

D. All corrections to address sound leaks uncovered by the testing shall be the responsibility of the Contractor, along with subsequent tests.

- E. At completion of the project, the door manufacturer's representative shall submit letter to the construction manager that installation and adjustment is complete and in accordance with approved Shop Drawings and Contract Documents, and that acoustical performance complies with specifications.

3.5 ADJUSTING

- A. Adjust hardware to function smoothly, and lubricate as recommended by manufacturer.

3.6 CLEANING

- A. Clean surfaces and refinish abraded or damaged surfaces to match factory finish.

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: By system manufacturer shall include the following:
 - 1. Provide shop drawings signed and sealed by qualified professional engineer responsible for their preparation licensed in the State of Texas.
 - a. Shop drawings shall clearly define the design criteria and applied loads for which the system has been designed.
 - b. Shop drawings shall clearly indicate magnitude and location of all forces transferred to the primary building structure by system. Loads shall be provided as unfactored values determined in accordance with ASCE 7-10.
 - 2. Plans, elevations, and sections.
 - 3. System and component dimensions.
 - 4. Details of components within assembly.
 - 5. Framed opening requirements and tolerances.
 - 6. Fasteners and attachments clearly indicating reactions to supporting elements and assumed eccentricities.
 - 7. Glass and infills.
 - 8. Anticipated deflection under load.
 - 9. Affected related work.
 - 10. Expansion and contraction joint locations and details.
 - 11. Drainage details and flow diagrams.
 - 12. Field welding.
 - 13. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
 - 14. Deferred-Design Submittal: Submit shop drawings to Authority Having Jurisdiction for approval prior to commencing with this work on-site.
- 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.
 3. Expansion provisions.
 4. Glazing.
 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. 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 INFORMATIONAL SUBMITTALS

- A. 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.

1.5 QUALITY ASSURANCE

- A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Michigan, with a minimum of 10 years' experience in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of glazed aluminum curtain wall systems that are similar to those indicated for this Project in material, design, and extent.
- B. Manufacturer and Fabricator Qualifications: A firm experienced in manufacturing and fabricating glazing systems similar to those indicated for this Project, having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project, being familiar with special requirements indicated; having complied with requirements of authorities having jurisdiction, and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Installer Qualifications: A firm or individual certified by fabricator and manufacturer, having successfully completed installation, erection or assembly of a minimum of five previous projects similar in nature, size, and extent to this Project, whose work has resulted in construction with a record of successful in-service performance.
- D. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code – Aluminum".
- E. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of curtain wall assemblies.

1.6 MOCKUPS

- A. Mock-Up 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 sample for pre-installation meeting.
- B. Provide mock-ups 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.

1.7 WARRANTY

- A. Provide manufacturer's warranty for 10 years on materials and 5 years on installation and workmanship.
- B. Provide written warranty in form acceptable to Owner jointly signed by manufacturer, installer and Contractor warranting work to be watertight, free from defective materials, defective workmanship, glass breakage due to defective design, and agreeing to replace components which fail within warranty period.
- C. Warranty Coverage: Cover complete system for failure to meet specified requirements, including ability to exclude exterior moisture from interior.
 - 1. Complete watertight and airtight system installation within specified tolerances.
 - 2. System is structurally sound and free from distortion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 - Quality Requirements, to design glazing systems.
- 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.
- 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.
- D. Deflection of Framing Members: At design wind pressure, as follows:
1. Deflection Normal to Wall Plane: When subjected to design wind loads or concentrated maintenance loads shall be limited to following:
 - a. Spans up to 13 feet-6 inches: limit deflection to $L/175$.
 - b. Spans greater than 13 feet-6 inches: limit deflection to $L/240$ plus 1/4 inch.
 - c. Cantilevered members: limit deflection to lesser of $2L/175$ or 3/4 inch.
 - d. No permanent deformation in excess of 0.2 percent of its span.
 - e. 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.
 2. 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.
 - a. Structural Support Movement: System to accommodate anticipated interstory differential live load vertical movement of 5/16 inch (downward) in addition to anticipated thermal movement.
 - b. Sidesway Movement: System to accommodate anticipated interstory differential drift of $H/400$ in any horizontal direction.
- E. Air Infiltration: Test according to ASTM E 283 and applicable AAMA methods for infiltration as follows:
1. Fixed Framing and Glass Area: Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft..
 2. Pair of Entrance Doors: Maximum air leakage of 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
 3. Single Entrance Doors: Maximum air leakage of 0.5 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
- F. 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 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.
- G. Energy Performance Requirements: Certify and label energy performance according to NFRC as follows:
1. Maximum Thermal Transmittance (U-factor) Fixed Glazing and Framing: 0.38 Btu/sq. ft. x h x deg F, as determined according to NFRC 100.
 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.40 as determined according to NFRC 200.
 3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 48 as determined according to NFRC 500.
- H. Noise Reduction: Test according to ASTM E 90, with ratings determined by ASTM E 1332, as follows:
1. Outdoor-Indoor Transmission Class (OITC): Minimum 30.
- I. 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.
- J. 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.
- K. Entrances: Provide entrance doors with jamb and head frames which comply with requirements indicated below for transmission characteristics and test methods.
 - 1. Air Leakage: Air infiltration per linear foot of perimeter crack of not more than 0.50 CFM for single doors and 1.0 CFM for pairs of doors per ASTM E283 at pressure differential of 1.567 psf.
 - 2. Thermal Transmittance: U-value of not more than 0.77 Btu per AAMA 1503.
 - 3. Condensation Resistance: Not less than 48 CRF per AAMA 1503.

2.2 BASIS OF DESIGN SYSTEMS

- A. Single Source Responsibility: To ensure quality of appearance and performance, obtain materials for all glazed framing 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. EFCO Corporation.
 - 2. Kawneer Company .
 - 3. Wausau Window and Wall Systems.
 - 4. Oldcastle BuildingEnvelope.
 - 5. YKK AP America Inc..
- C. 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): Lobby curtain wall with reinforced mullions, special shape caps and SSG.
 - b. (AFS-2): all SSG curtain wall .
 - c. (AFS-3): Curtain wall with 6" deep caps.
 - 3. Finish: Color Anodized, AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: Black, matching Architect's sample.
- D. 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.
 - 1. Basis of Design: TriFab 451 UT by Kawneer.
 - 2. Configurations:
 - a. (AFS-4): Storefront at South elevation
 - b. (AFS-5): Entrance doors at vestibule and South elevation
 - 3. Finish: Color Anodized, AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: Black, matching Architect's sample.
- E. Entrances: Curtain wall Manufacturer's standard glazed entrance doors for manual-swing operation.
 - 1. Profiles: 4" wide medium stiles and top rail, and 10" bottom rail.
 - 2. Door Construction: 1-3/4-inch overall depth, with minimum 0.125-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.
 - a. Color: Black, matching Architect's sample.
5. Entrance Door Hardware: As specified in Section 087100 - Door Hardware.

2.3 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.
 - c. Extruded Structural Pipe and Tubes: ASTM B 429.
 - 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.
 3. Hot-Rolled Sheet and Strip: ASTM A 570.

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

2.4 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:
 1. Comply with recommendations of the American Welding Society.
 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.

2.5 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. 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.
- B. 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).
- C. 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. Retesting: Make corrections to and retest area until satisfactory results are achieved.
 - 3. 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.
- D. 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 impart 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 084520
TRANSLUCENT FIBERGLASS PANEL ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Aluminum-framed wall assemblies incorporating translucent fiberglass-sandwich panels (_____).
 2. Anchors, brackets, and attachments.
 3. Flashings to adjoining work.
 4. Perimeter sealant.

2.1 SUBMITTALS

- A. Shop Drawings and Product Data: Submit in accordance with Section 013300.
1. Include system and component dimensions; component within assembly; framed opening requirements and tolerances; anchorage and fasteners; affected related work; expansion and contraction joint locations and details; and drainage details.
 2. Exchange shop drawings with fabricators of related adjacent materials.
 3. Structural calculations available upon request by A/E.
- B. Samples: Submit in accordance with Section 013300. Submit samples illustrating prefinished aluminum surface, specified panel with skins, including glazing edge and corner.
- C. Fabrication Samples: Of each framing system intersection and adjacent panels, made from 12-inch lengths of full-size framing members and showing details of the following:
1. Joinery.
 2. Anchorage.
 3. Expansion provisions.
 4. Fiberglass-sandwich panels.
 5. Flashing and drainage.
- D. Qualification Data: For qualified **Installer, manufacturer**.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for panel assemblies.
- F. Field quality-control reports.
- G. Maintenance Data: For panel assemblies to include in maintenance manuals.

1.2 QUALITY ASSURANCE

- A. Manufacturer Qualifications: For fiberglass-sandwich panels, a qualified manufacturer whose facilities, processes, and products are monitored by an independent, accredited quality-control agency for compliance with applicable requirements in ICC-ES AC04, "Sandwich Panels," or ICC-ES AC177, "Translucent Fiberglass Reinforced Plastic (FRP) Faced Panel Wall, Roof and Skylight Systems."
- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of panel assemblies required for this Project.
1. One Installer for Total System: Company authorized by system manufacturer.
- 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. Build mockup of typical panel assemblies as shown on Drawings.
 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. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.3 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of panel assemblies that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - c. Water leakage.
 - 2. Warranty Period: Five years from date of Substantial Completion.
- B. Special Fiberglass-Sandwich-Panel Warranty: Manufacturer's standard form in which manufacturer agrees to replace panels that exhibit defects in materials or workmanship.
 - 1. Defects include, but are not limited to, the following:
 - a. Fiberbloom.
 - b. Delamination of coating, if any, from exterior face sheet.
 - c. Color change exceeding requirements.
 - d. Delamination of panel face sheets from panel cores.
 - 2. Warranty Period: 10 years from date of Substantial Completion.
- C. Special Aluminum-Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
 - 1. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Fiberglass-sandwich-panel assemblies shall withstand the effects of the following forces without failure due to defective manufacture, fabrication, installation, or other defects in construction:
 - 1. Structural loads.
 - 2. Thermal movements.
 - 3. Movements of supporting structure.
- B. 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.
- C. Design and size members to withstand dead loads and live loads caused by snow, hail, and pressure and suction of wind acting vertically as calculated in accordance with Uniform Building Code. System must be designed by licensed engineer registered in State of **[insert name of State]**.
- D. System to accommodate, without damage to system or components, or deterioration of perimeter seal: Movement within system; movement between system and perimeter framing components; dynamic loading and release of loads; and deflection of structural support framing.
- E. Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to exterior.

2.2 PRODUCTS AND MANUFACTURERS

- A. Products and Manufacturers:
 - 1. Kalwall Corporation.
 - 2. Major Industries, Inc.
 - 3. Skywall Translucent Systems; Vistawall Group (The).
 - 4. Structures Unlimited, Inc.

2.3 TRANSLUCENT WALL PANEL ASSEMBLIES

- A. (TSPA-1) Wall Panel Assembly: Including translucent fiberglass-sandwich panels and thermally-broken extruded aluminum framing.
 - 1. Basis of Design: Kalwall.
- B. Panels: Assembly of uniformly colored, translucent, thermoset, fiberglass-reinforced-polymer face sheets bonded to both sides of thermally-broken grid core.
 - 1. Thickness: 2.75 inches.
 - 2. Grid Pattern: Grid Core Vertikal Grid Pattern.
- C. Frame Components: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.
 - 1. Construction: Thermally broken, extruded aluminum.
- D. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.
 - 1. Sheet and Plate: ASTM B 209.
 - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - 3. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - 4. Structural Profiles: ASTM B 308/B 308M.
- E. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.
- F. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding fasteners and accessories; compatible with adjacent materials.
 - 1. At closures, retaining caps, or battens, use ASTM A 193/A 193M, 300 series stainless-steel screws.
 - 2. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 3. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.

2.4 ALUMINUM FRAMING SYSTEMS

- A. Framing Components: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.
 - 1. Construction: Thermally broken, extruded aluminum.
- B. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.
 - 1. Sheet and Plate: ASTM B 209.
 - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - 3. Extruded Structural Pipe and Tubes: ASTM B 429.
 - 4. Structural Profiles: ASTM B 308.
- C. Finish:
 - 1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
 - 2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: [Light bronze] [Medium bronze] [Dark bronze] [Champagne] [Black] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities].
 - 3. High-Performance Fluoropolymer Finish: AAMA 2605, multi-coat system containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat [and clear topcoat].
 - a. Two-Coat System: Primer and color coat.
 - b. Three-Coat System: Primer, color coat, and clear topcoat.
 - c. Two-Coat Mica System: Primer and color coat with suspended mica flakes.
 - d. Three-Coat Metallic System: Primer, color coat with suspended metallic flakes, and clear topcoat.

- e. Color and Gloss: [Custom color matching PT-___] [Custom color matching Architect's sample] [As selected by Architect from manufacturer's full range].
- D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.
- E. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding fasteners and accessories; compatible with adjacent materials.
 - 1. At closures, retaining caps, or battens, use ASTM A 193/A 193M, 300 series stainless-steel screws.
 - 2. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 3. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.
- F. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123 or ASTM A 153 requirements.
- G. Anchor Bolts: ASTM A 307, Grade A, galvanized steel.
- H. Concealed Flashing: Corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- I. Exposed Flashing and Closures: Aluminum sheet, finished to match framing.
- J. Framing Gaskets: Manufacturer's standard.
- K. Framing-System Sealants: As recommended in writing by manufacturer.
- L. Corrosion-Resistant Coating: 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.

2.5 FABRICATION

- A. Frame System Fabrication:
 - 1. Fabricate components before finishing.
 - 2. Fabricate components that, when assembled, have the following characteristics:
 - a. Profiles that are sharp, straight, and free of defects or deformations.
 - b. Accurately fitted joints with ends coped or mitered.
 - c. Internal guttering systems or other means to drain water passing through joints, condensation occurring within components, and moisture migrating within assembly to exterior.
 - 3. Fabricate sill closures with weep holes and for installation as continuous component.
 - 4. Reinforce components as required to receive fastener threads.
- B. Panel Fabrication: Factory assemble and seal panels.
 - 1. Laminate face sheets to grid core under a controlled process using heat and pressure to produce straight adhesive bonding lines that cover width of core members and that have sharp edges.
 - a. White spots indicating lack of bond at intersections of grid-core members are limited in number to four for every 40 sq. ft. of panel and limited in diameter to 3/64 inch.
 - 2. Fabricate with grid pattern that is symmetrical about centerlines of each panel.
 - 3. Fabricate panel to allow condensation within panel to escape.
 - 4. Reinforce panel corners.

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. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Installation, General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure nonmovement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and immobilization of moving joints.
 - 6. Seal joints watertight unless otherwise indicated.
- B. Metal Protection: Where aluminum components will contact dissimilar materials, protect against galvanic action by painting contact surfaces with corrosion-resistant coating or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
- C. Install continuous aluminum sill closures with weatherproof expansion joints and locked and sealed corners. Locate weep holes at rafters.
- D. Install components to drain water passing through joints, condensation occurring within aluminum members and panels, and moisture migrating within assembly to exterior.
- E. Install components plumb and true in alignment with established lines and elevations.

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
 - 4. St.Cloud Windows.
- C. Factory-glazed aluminum-framed sound-control window units, conforming to or exceeding HS-DW-C25 and specified requirements.
- D. Aluminum-framed, factory-glazed window units; acoustically tested & rated; prefinished matte black;
 - 1. Basis of Design: DeVAC 600 Series by Mon-Ray Inc.
- E. (SCWU-1) Fixed Frame: Aluminum-framed unit with fixed frame; factory-glazed with laminated glass; installed vertically at 5-degree angle in wall assembly.
 - 1. Sound Transmission Class (STC): Rated for not less than STC 45 when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
 - 2. Basis of Design: DeVAC 650-AL by Mon-Ray Inc..
- F. (SCWU-2) Double-Glazed Unit with Sliding Sashes(: Aluminum-framed unit with sliding sashes; factory-glazed with laminated glass; installed vertically at 5-degree angle in wall assembly.
 - 1. 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.
 - 2. Basis of Design: DeVAC 650-AL by Mon-Ray Inc..
- 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. Finishes: 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 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte.
 - 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.
 - 3. Color: Matching PT-3 (Black).
- I. Glazing: Sash shall be factory glazed with the following:
 - 1. Operable Sections: **3/8-inch** laminated glass (**STC 36**) plus 1/4-inch plate glass (**STC 31**) separated by the air space shown on the drawings.
 - 2. Fixed Section: **1/2-inch** thick monolithic projection quality glass as specified.
 - 3. Clear annealed glass, ASTM C 1036, Type 1, Class 1, q3. Kind: Fully tempered [where indicated on Drawings].
 - 4. **(GL-5)** and **(GL-5T)** Glass at **Projection Booth**: Lite shall be laminated, **ultra-clear, low-iron** float glass with a visible light transmission exceeding 90% through a 6.0mm test sample.
 - a. Configuration: Laminated glass unit, nominally **1/2-inch** thick comprising two sheets of clear float glass, 1/4-inch thick, bond laminated with a 0.030" thick polyvinyl butyral interlayer.

- b. Bonding process must exclude dirt, air pockets and foreign substances. Inclusions shall not exceed 3 psc/kg. The glass shall be select glazing quality (q3), Type I, Class I, free of defects that would affect normal viewing.
 - c. Edges shall be flame polished and beveled. Both sides of the glass shall have an anti-reflective coating such that residual reflection when viewed at a 90o angle shall be less than 1%.
 - d. Basis of Design Glass: Amiran Low-Iron Glass by Schott North America, Inc.
- J. Weather-stripping: Double weather-stripped silicoated 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. Hardware: Spring loaded stainless steel plunger lock. Interior meeting rails to have continuous grip rails.
- L. 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 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 01 Section "Sustainable Design Requirements" for additional LEED documentation and requirements.
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.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. Michigan Building Code 2015, Local Amendments.

- 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 SUBMITTALS

- 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. 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.
- F. 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 Submittals.
- 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. 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.
- E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

- F. 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.
- G. 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
- H. 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.

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. Twenty five years for manual surface door closer bodies.
 - 5. Twenty five years for manual surface door closer bodies.
 - 6. Five years for motorized electric latch retraction exit devices.
 - 7. 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).
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
 - c. Stanley Hardware (ST).
- 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. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
 - c. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 - d. 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. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
 - d. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 - e. 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. Stanley Hardware (ST) EPT-12C Series.
 - c. Von Duprin (VD) - EPT-10 Series.

- B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
1. Provide one each of the following tools as part of the base bid contract:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Electrical Connecting Kit: QC-R001.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Connector Hand Tool: QC-R003.
 2. Manufacturers:
 - a. Hager Companies (HA) - Quick Connect.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – QC-C Series.
 - c. Stanley Hardware (ST) – WH 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. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 4. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Ives (IV).
 - c. 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.
 5. Keyway: Match Facility Standard.
- 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: Key locks to 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).
3. Construction Keys (where required): Ten (10).
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. Mortise locks to be certified Security Grade 1.
2. Extended cycle test: Locks to have been cycle tested in ordinance with ANSI/BHMA 156.13 requirements to 10 million cycles.
3. Manufacturers:
 - a. Corbin Russwin Hardware (RU) – ML2000 Series.
 - b. Stanley Best (BE) – 40H-UN Series.

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.

- b. Stanley Best (BE) - 40HW EL/EU Series.

2.8 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 - 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
 - 4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.
- B. Standards: Comply with the following:
 - 1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 - 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 - 3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
 - 4. Dustproof Strikes: BHMA A156.16.

2.9 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. 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.
 7. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.
 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. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 11. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 12. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 13. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. 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) - 35A/98 XP Series.

2.10 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, 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.

2.11 ELECTROMECHANICAL 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.
- 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.

2.12 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.

2.13 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.

2.14 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:

- a. Hiawatha, Inc. (HI).
- b. Ives (IV).
- c. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

2.15 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. Hiawatha, Inc. (HI).
 - b. Ives (IV).
 - c. 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).

2.16 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).

2.17 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 (SN) – 1076D (double pole / double throw).
- 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 for the specified electrified hardware and access control equipment.
 1. Manufacturers:
 - a. Security Door Controls (SD) - 630 Series.
 - b. Securitron (SU) - BPS Series.
 - c. Von Duprin (VD) - PS.

2.18 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.

2.19 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.
- B. Wood Doors: Comply with ANSI/DHI A115-W 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:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 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: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

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. Manufacturer's Abbreviations:
 - 1. MK - McKinney
 - 2. PE - Pemko
 - 3. MR - Markar
 - 4. RO - Rockwood
 - 5. SA - Sargent
 - 6. RU - Corbin Russwin
 - 7. SU - Securitron
 - 8. BE - dormakaba Best
 - 9. RF - Rixson
 - 10. LC - LCN Closers
 - 11. OT - OTHER
 - 12. NO - Norton

Hardware Sets

Set: 1.0

Doors: 134EE

1 Continuous Hinge	CFM-SLF-HD1 x PT		PE
1 Exit Device (nightlatch)	LC 16 43 55 56 8804	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
1 Pull	RM201 Mtg-Type 12XHD	US32D-316	RO
1 Conc Overhead Stop	6-X36	630	RF
1 Surface Closer	DC8220 top jamb x mounting plate to suit application	689	RU
1 Threshold	1715AK MSES25SS		PE

1 Weatherstrip	- integral within construction of door and frame assembly	00
1 Sweep	29326CNB x TKSP8	PE
1 Door Contact	1076D (DPDT)	OT
1 Electric Power Transfer	EL-CEPT	SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)	MK <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to exit device rail)	MK <input type="checkbox"/>
1 Intercom System	- Provided by Security Contractor	OT
1 Linear Power Supply	BPS-24-2 (electric latch retraction)	SU <input type="checkbox"/>
1 Card Reader	- Provided by Security Contractor	00

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 fo door monitoring upon egress. Free egress always permitted.

Set: 2.0

Doors: 0110

1 Continuous Hinge	CFM-SLF-HD1 x PT		PE
1 Exit Device (nightlatch)	LC 16 43 53 55 56 8804	US32D	SA <input type="checkbox"/>
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 Pull	RM201 Mtg-Type 12XHD	US32D-316	RO
1 Conc Overhead Stop	6-X36	630	RF
1 Door Operator	4642 REG/LONG- confirm head detail	AL	LC
1 Threshold	1715AK MSES25SS		PE
1 Weatherstrip	- integral within construction of door and frame assembly		00
1 Sweep	29326CNB x TKSP8		PE
1 Door Contact	1076D (DPDT)		OT
1 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to exit device rail)		MK <input type="checkbox"/>
1 Actuator Switch	ADA1019-3 - DPDT switch		NO
1 Pedestal	- to house card reader and exterior ADA operator switch		OT

1 Door Switch	505 (6" x 6")	NO	<input type="checkbox"/>
1 Linear Power Supply	BPS-24-2 (electric latch retraction)	SU	<input type="checkbox"/>
1 Card Reader	- Provided by Security Contractor	00	

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: 554

1 Continuous Hinge	CFM-SLF-HD1 x PT		PE
1 Exit Device (nightlatch)	LC 16 43 53 55 56 8804	US32D	SA <input type="checkbox"/>
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 Pull	RM201 Mtg-Type 12XHD	US32D-316	RO
1 Conc Overhead Stop	6-X36	630	RF
1 Door Operator	4642 REG/LONG- confirm head detail	AL	LC
1 Threshold	1715AK MSES25SS		PE
1 Weatherstrip	- integral within construction of door and frame assembly		00
1 Sweep	29326CNB x TKSP8		PE
1 Door Contact	1076D (DPDT)		OT
1 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to exit device rail)		MK <input type="checkbox"/>
1 Actuator Switch	ADA1019-3 - DPDT switch		NO
1 Pedestal	- to house card reader and exterior ADA operator switch		OT
1 Door Switch	505 (6" x 6")		NO <input type="checkbox"/>
1 Linear Power Supply	BPS-24-2 (electric latch retraction)		SU <input type="checkbox"/>
1 Card Reader	- Provided by Security Contractor		00

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.
Exit device equipped with signal switch in push rail to act as shunt fo 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: 4.0

Doors: 011N, 011P

1 Continuous Hinge	CFM-SLF-HD1 x PT		PE
1 Removable Mullion	L980A	US28	SA
1 Exit Device (exit only)	LC 16 43 55 56 8810	US32D	SA <input type="checkbox"/>
1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
1 Pull	RM201 Mtg-Type 12XHD	US32D-316	RO
1 Conc Overhead Stop	6-X36	630	RF
1 Surface Closer	DC8220 A1 - top jamb x mounting plate to suit application	689	RU
1 Threshold	1715AK MSES25SS		PE
1 Weatherstrip	- integral within construction of door and frame assembly		00
1 Sweep	29326CNB x TKSP8		PE
1 Door Contact	1076D (DPDT)		OT
1 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to exit device rail)		MK <input type="checkbox"/>
1 Linear Power Supply	BPS-24-2 (electric latch retraction)		SU <input type="checkbox"/>

Notes: Door normally closed and locked. Key inside controls manual dogging of latch bolt for push / pull operation.
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 fo door monitoring upon egress.
Free egress always permitted.

Set: 5.0

Doors: 011M

1 Continuous Hinge	CFM-SLF-HD1 x PT		PE
1 Exit Device (exit only)	LC 16 43 55 56 8810	US32D	SA <input type="checkbox"/>

1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
1 Pull	RM201 Mtg-Type 12XHD	US32D-316	RO
1 Conc Overhead Stop	6-X36	630	RF
1 Surface Closer	DC8220 A1 - top jamb x mounting plate to suit application	689	RU
1 Weatherstrip	- integral within construction of door and frame assembly		00
1 Sweep	29326CNB x TKSP8		PE
1 Door Contact	1076D (DPDT)		OT
1 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to exit device rail)		MK <input type="checkbox"/>
1 Linear Power Supply	BPS-24-2 (electric latch retraction)		SU <input type="checkbox"/>

Notes: Door normally closed and locked. Key inside controls manual dogging of latch bolt for push / pull operation.
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 fo door monitoring upon egress.
Free egress always permitted.

Set: 6.0

Doors: 1554

1 Continuous Hinge	CFM-SLF-HD1 x PT		PE
1 Exit Device (delayed egress, exit only)	LC 43 59 8810	US32D	SA <input type="checkbox"/>
1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
1 Conc Overhead Stop	6-X36	630	RF
1 Surface Closer	DC8220 top jamb x mounting plate to suit application	689	RU
1 Threshold	279x292AFGPK x MSES25SS		PE
1 Weatherstrip	- integral within construction of door and frame assembly		00
1 Sweep	29326CNB x TKSP8		PE
1 Door Contact	1076D (DPDT)		OT
1 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to exit device rail)		MK <input type="checkbox"/>

1 Power Supply BPS-24 (amp capacity as required) SU

Notes: Door normally closed and locked. Depressing push pad denies egress for period of 15 seconds while alarm signals unauthorized egress. After 15 seconds, the device releases permitting egress. Immediate egress is permitted upon activation of fire alarm, sprinkler system, or loss of power. Door is capable of being released after receipt of signal from Fire Command Center. Alarm will sound if the door is not closed and latched when arming the device or if the door is forced open when the device is armed. Device equipped with latchbolt monitor switch to monitor position of latchbolt.

Set: 7.0

Doors: N/A - 1846443

1 Continuous Hinge	CFM-HD1 x PT		PE
1 Electrified Rim Exit (fail secure lever)	LC 43 55 8876-24v ETL	US32D	SA <input type="checkbox"/>
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 4BE 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	216BD CFG x TKSP8		PE
1 Door Contact	1076D (DPDT)		OT
1 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to exit device rail)		MK <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to exit device lever trim)		MK <input type="checkbox"/>
1 Power Supply	BPS-24 (amp capacity as required)		SU <input type="checkbox"/>
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: 8.0

Doors: 126C

1 Continuous Hinge	CFM-HD1		PE
1 Exit Device (nightlatch)	LC 16 43 8804	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
1 Vandal Resistant Trim	VRT22 C	US32D	RO
1 Surface Closer	DC6210 A4	689	RU
1 Kick Plate	K1050 10" high 4BE 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	216BDCFG x TKSP8		PE
1 Door Contact	1076D (DPDT)		OT

Notes: Function: Key outside retracts latch bolt. Keyed cylinder inside controls latch bolt dogging. Free egress always permitted.

Set: 9.0

Doors: 134DB, 135E

1 Continuous Hinge	CFM-HD1 x PT		PE
1 Exit Device (delayed egress, exit only)	LC 43 59 8810	US32D	SA <input type="checkbox"/>
1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
1 Surface Closer	DC8210 A4	689	RU
1 Threshold	279x292AFGPK 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	1076D (DPDT)		OT
1 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to exit device rail)		MK <input type="checkbox"/>
1 Power Supply	BPS-24 (amp capacity as required)		SU <input type="checkbox"/>

Notes: Door normally closed and locked. Depressing push pad denies egress for period of 15 seconds while alarm signals unauthorized egress. After 15 seconds, the device releases permitting egress. Immediate egress is permitted upon activation of fire alarm, sprinkler system, or loss of power. Door is capable of being released after receipt of signal from Fire Command Center. Alarm will sound if the door is not closed and latched when arming the device or if the door is forced open when the device is armed. Device equipped with latchbolt monitor switch to monitor position of latchbolt.

Set: 10.0

Doors: 020

3 Hinge (heavy weight)	T4A3386 / T4A4386 x NRP	US32D	MK
1 Storeroom Lock	ML2057 NSA LC	626	RU
1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
1 Surface Closer	DC8200 - pull side mount	689	RU
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
1 Threshold	279x292AFGPK x MSES25SS		PE
1 Weatherstrip	2891APK x TKSP8 - head and jambs		PE
1 Door Bottom	216BDCFG x TKSP8		PE

Notes: 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: 150AAAA, 150BBBB, 150DDDD

1 Continuous Hinge	CFM-SLF-HD1		PE
1 Push Pull	RM251 Mtg-Type 12XHD Mtg-Type 11XHD	US32D-316	RO
1 Conc Overhead Stop	6-X36	630	RF
1 Surface Closer	DC8220 top jamb x mounting plate to suit application	689	RU

Set: 12.0

Doors: 1397, 150CCCC

1 Continuous Hinge	CFM-SLF-HD1		PE
1 Push Pull	RM251 Mtg-Type 12XHD Mtg-Type 11XHD	US32D-316	RO
1 Conc Overhead Stop	6-X36	630	RF
1 Door Operator	4642 REG/LONG- confirm head detail	AL	LC
2 Door Switch	505 (6" x 6")		NO <input type="checkbox"/>

Set: 13.0

Doors: 151A

4 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
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2	Electrified SVR Exit (fail secure lever)	43 55 NB8774-24v ETL	US32D	SA	<input type="checkbox"/>
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 4BE CSK	US32D	RO	
1	Door Contact	1076D (DPDT)		OT	
1	Electric Power Transfer	EL-CEPT		SU	<input type="checkbox"/>
1	ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK	<input type="checkbox"/>
1	ElectroLynx Harness	QC-C (power transfer to exit device rail)		MK	<input type="checkbox"/>
1	ElectroLynx Harness	QC-C (power transfer to exit device lever trim)		MK	<input type="checkbox"/>
1	Power Supply	BPS-24 (amp capacity as required)		SU	<input type="checkbox"/>
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.
Fail-secure lever. Loss of power to lever trim locks lever.
Activation of fire alarm immediately unlocks lever trim
Free egress always permitted.

Set: 14.0

Doors: 134E, 179A

4	Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK	
1	Electrified Rim Fire Exit (fail secure lever)	12 LC 43 55 8876-24v ETL	US32D	SA	<input type="checkbox"/>
1	Rim 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 4BE CSK	US32D	RO	
1	Wall Stop	406	US32D	RO	
1	Smoke / Sound Seal	S88D - head and jambs		PE	
1	Door Contact	1076D (DPDT)		OT	
1	Electric Power Transfer	EL-CEPT		SU	<input type="checkbox"/>
1	ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK	<input type="checkbox"/>
1	ElectroLynx Harness	QC-C (power transfer to exit device rail)		MK	<input type="checkbox"/>
1	ElectroLynx Harness	QC-C (power transfer to exit device lever trim)		MK	<input type="checkbox"/>
1	Power Supply	BPS-24 (amp capacity as required)		SU	<input type="checkbox"/>
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: 127A, 254A

6 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
2 Surface Vert Rod Exit	LC 43 NB8706 ETL	US32D	SA
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 4BE 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: 16.0

Doors: 185C

4 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Exit Device (storeroom)	LC 43 8804 ETL	US32D	SA
1 Rim 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 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
3 Silencer	608 / 609		RO

Notes: Key outside retracts latch bolt. Outside lever rigid.
 Free egress always permitted.

Set: 17.0

Doors: 165A, 177AA

8 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
2 Surface Vert Rod Exit	43 NB8710	US32D	SA

2 Surface Closer	DC6210 A3	689	RU
2 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
2 Door Stop & Holder	490	US26D	RO
2 Silencer	608 / 609		RO

Notes: Exit only. No outside trim.
Free egress always permitted.

Set: 18.0

Doors: 145

8 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
2 Exit Device (classroom)	LC 43 NB8713 ETL	US32D	SA
2 Rim Cylinder	- match Owner's existing Best key system	626	BE
2 Surface Closer	DC6200 - pull side mount	689	RU
2 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
2 Wall Stop	406	US32D	RO
2 Silencer	608 / 609		RO

Notes: Key outside locks or unlocks lever trim. Free egress always permitted.

Set: 19.0

Doors: 134A, 134B

8 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
2 Exit Device (classroom)	LC 43 NB8713 ETL	US32D	SA
2 Rim Cylinder	- match Owner's existing Best key system	626	BE
2 Surface Closer	DC6210 A3	689	RU
2 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
2 Door Stop & Holder	490	US26D	RO
1 Sound / Smoke Seal	S773D - head and jambs		PE
2 Conc. Auto. Door Bottom	420APKL		PE
1 Meeting Edge Seal	S772C x height of door		PE

Notes: Key outside locks or unlocks lever trim. Free egress always permitted.

Set: 20.0

Doors: 177A

3 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Exit Device (classroom)	43 8813 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 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
3 Silencer	608 / 609		RO

Notes: Key outside locks or unlocks lever trim. Free egress always permitted.

Set: 21.0

Doors: 134CA, 150AA, 150BA, 150CA

4 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Exit Device (classroom)	43 8813 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 4BE 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: Key outside locks or unlocks lever trim. Free egress always permitted.

Set: 22.0

Doors: 136C, 136D

3 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Fire Exit Device (classroom)	12 LC 43 8813 ETL	US32D	SA
1 Rim Cylinder	- match Owner's existing Best key system	626	BE
1 Surface Closer	DC6210 A3	689	RU
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
1 Smoke / Sound Seal	S88D - head and jambs		PE

Notes: Key outside locks or unlocks lever trim. Free egress always permitted.

Set: 23.0

Doors: 136A, 136B

3 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Fire Exit Device (classroom)	12 LC 43 8813 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 4BE CSK	US32D	RO
1 Smoke / Sound Seal	S88D - head and jambs		PE

Notes: Key outside locks or unlocks lever trim. Free egress always permitted.

Set: 24.0

Doors: 135A, 135B

8 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
2 Fire Exit Device (passage)	12 43 NB8715 ETL	US32D	SA
2 Surface Closer	DC6200 - pull side mount	689	RU
2 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
2 Door Stop & Holder	490	US26D	RO
1 Sound / Smoke Seal	S773D - head and jambs		PE
2 Conc. Auto. Door Bottom	420APKL		PE
1 Meeting Edge Seal	S772C x height of door		PE

Notes: Passage lever trim.
Free egress always provided.

Set: 25.0

Doors: 150HH

8 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
2 Fire Exit Device (passage)	12 43 NB8715 ETL	US32D	SA
2 Surface Closer	DC6210 A3	689	RU
2 Kick Plate	K1050 10" high 4BE 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: ** Door 150HH - install doors for 180 degree swing.

Passage lever trim.
Free egress always provided.

Set: 26.0

Doors: 011A

3 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Exit Device (passage)	43 8815 ETL	US32D	SA
1 Surface Closer	DC6200 - pull side mount	689	RU
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
1 Smoke / Sound Seal	S88D - head and jambs		PE
1 Sound / Smoke Seal	S773D - head and jambs		PE
1 Conc. Auto. Door Bottom	420APKL		PE

Notes: Passage lever trim.
Free egress always permitted.

Set: 27.0

Doors: 011, 011B

3 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Electrified Rim Exit (fail safe lever)	12 LC 43 55 8875-24v ETL	US32D	SA <input type="checkbox"/>
1 Rim 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 4BE 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
1 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to exit device lever trim)		MK <input type="checkbox"/>
1 Power Supply	BPS-24 (amp capacity as required)		SU <input type="checkbox"/>

Notes: Door normally closed and unlocked. Free egress always permitted..
When orchestra pit is in operation, lever trim is energized and door is locked - no entry permitted.
When orchestra pit is not in operation, lever trim is unlocked.

System to be designed by theatre consultant.

Set: 28.0

Doors: 017, 1165, 190A, 290A

3 Hinge (heavy weight)	T4A3786 / T4A4786	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 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
1 Smoke / Sound Seal	S88D - head and jambs		PE

Notes: Passage lever trim.
Free egress always permitted.

Set: 29.0

Doors: 134DA

3 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Fire Exit Device (passage)	12 43 8815 ETL	US32D	SA
1 Surface Closer	DC6210 A4	689	RU
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1 Sound / Smoke Seal	S773D - head and jambs		PE
1 Conc. Auto. Door Bottom	420APKL		PE

Notes: Passage lever trim.
Free egress always permitted.

Set: 30.0

Doors: 181A

8 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
2 Flush Bolt	555 / 557	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Electrified Mortise 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
2 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
2 Wall Stop	406	US32D	RO
2 Silencer	608 / 609		RO
2 Door Contact	1076D (DPDT)		OT
1 Electric Power Transfer	EL-CEPT		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 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: 31.0

Doors: 123A, 131, 162A, 177CA, 177DA, 252A, 335A

2 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Electrified Mortise Lock	ML20906-SEC NSA M92 LC	626	RU <input type="checkbox"/>
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 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
3 Silencer	608 / 609		RO
1 Door Contact	1076D (DPDT)		OT
1 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to lock or electric strike location)		MK <input type="checkbox"/>
1 Power Supply	BPS-24 (amp capacity as required)		SU <input type="checkbox"/>
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: 32.0

Doors: 1601, 249A, 249B

2 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Electrified Mortise Lock	ML20906-SEC NSA M92 LC	626	RU <input type="checkbox"/>
1 Surface Closer	DC6210 A3	689	RU
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
3 Silencer	608 / 609		RO
1 Door Contact	1076D (DPDT)		OT
1 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK <input type="checkbox"/>

1 ElectroLynx Harness	QC-C (power transfer to lock or electric strike location)	MK	<input type="checkbox"/>
1 Power Supply	BPS-24 (amp capacity as required)	SU	<input type="checkbox"/>
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: 33.0

Doors: 125A, 1603, 165B, 166A, 167A, 195L, 195N, 253A

2 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Electrified Mortise Lock	ML20906-SEC NSA M92 LC	626	RU <input type="checkbox"/>
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 4BE CSK	US32D	RO
3 Silencer	608 / 609		RO
1 Door Contact	1076D (DPDT)		OT
1 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to lock or electric strike location)		MK <input type="checkbox"/>
1 Power Supply	BPS-24 (amp capacity as required)		SU <input type="checkbox"/>
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: 171A, 180A

6 Hinge	TA2714 / TA4714	US26D	MK
2 Flush Bolt	555 / 557	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	ML2057 NSA LC	626	RU
1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
2 Surf Overhead Hold Open	9-X26	652	RF

2 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
2 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: 36.0

Doors: 120A

3 Hinge	TA2714 / TA4714	US26D	MK
1 Storeroom Lock	ML2057 NSA LC	626	RU
1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
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: 37.0

Doors: 178A

4 Hinge	TA2714 / TA4714	US26D	MK
1 Storeroom Lock	ML2057 NSA LC	626	RU
1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
1 Surf Overhead Hold Open	10-X26	652	RF
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
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: 38.0

Doors: 132D, 132F, 1595

3 Hinge	TA2714 / TA4714	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 4BE CSK	US32D	RO

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: 39.0

Doors: 011C

3 Hinge	TA2714 / TA4714	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: 40.0

Doors: 015, 132BA, 150AA

3 Hinge	TA2714 / TA4714	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 4BE 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: 41.0

Doors: 140A, 165CA, 165DA, 177EA, 182A, 184A

3 Hinge	TA2714 / TA4714	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: 42.0

Doors: 161A, 176A

3 Hinge	TA2714 / TA4714	US26D	MK
1 Entrance Lock	ML2053 NSA LC	626	RU
1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
1 Conc Overhead Stop	2-X36	652	RF
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: 43.0

Doors: 165EA, 183A

3 Hinge	TA2714 / TA4714	US26D	MK
1 Passage Latch	ML2010 NSA	626	RU
1 Wall Stop	406	US32D	RO
3 Silencer	608 / 609		RO

Set: 44.0

Doors: 150TT, 250C, 250D

3 Hinge	TA2714 / TA4714	US26D	MK
1 Passage Latch	ML2010 NSA	626	RU
1 Surf Overhead Stop	10-X36	652	RF
3 Silencer	608 / 609		RO

Set: 45.0

Doors: 167AA

3 Hinge	TA2714 / TA4714	US26D	MK
1 Classroom Lock	ML2055 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: 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: 46.0

Doors: 165AA, 165BA

4 Hinge	TA2714 / TA4714	US26D	MK
1 Privacy Lock	ML2060 NSA M34 M19V	626	RU
1 Conc Overhead Stop	2-X36	652	RF
3 Silencer	608 / 609		RO

Notes: Latchbolt operated by lever either side, except when outside lever is locked by thumbturn inside. Operating inside lever, closing door or operating emergency key outside unlocks outside lever. Inside lever always free for egress.

Occupancy indicator shows if room is occupied or vacant.

Set: 47.0

Doors: 154A, 155A, 174A, 175A

3 Hinge	TA2714 / TA4714	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 Surface Closer	DC6200 - pull side mount	689	RU
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
3 Silencer	608 / 609		RO
1 Coat Hook	796	US26D	RO

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: 48.0

Doors: 121A, 122A

3 Hinge	TA2714 / TA4714	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 Conc Overhead Hold Open	2-X26	652	RF
1 Surface Closer	DC8200 - pull side mount	689	RU
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
3 Silencer	608 / 609		RO

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.

Set: 49.0

Doors: 163BA, 164BA, 172BA, 173BA

4 Hinge	TA2314 / TA4314	US32D	MK
1 Privacy Lock	ML2060 NSA M34 M26 M19V	630	RU
1 Wall Stop	406	US32D	RO
3 Silencer	608 / 609		RO

Notes: Latch bolt operated by lever either side, except when outside lever is locked by thumb turn inside. Operating inside lever, closing door or operating emergency key outside unlocks outside lever. Inside lever always free for egress. Occupancy indicator shows if room is occupied or vacant.

Set: 50.0

Doors: 153A

8 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
2 Flush Bolt	555 / 557	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	ML2057 NSA LC	626	RU
1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
2 Surf Overhead Stop	9-X36	652	RF
2 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
2 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: 51.0

Doors: 177BA

6 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
2 Flush Bolt	555 / 557	US26D	RO

1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	ML2057 NSA LC	626	RU
2 Surf Overhead Hold Open	9-X26	652	RF
2 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
2 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: 52.0

Doors: 270A, 270AA, 270AB

6 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
2 Flush Bolt	555 / 557	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	ML2057 NSA LC	626	RU
2 Conc Overhead Stop	1-X36	652	RF
2 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
2 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: 53.0

Doors: 010A, 012, 013, 018

6 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Comb. Flush Bolt Set	2845 (HM) / 2945 (WD)	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	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 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.

Set: 54.0

Doors: 163A, 164A, 172A, 173A

4 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Entrance Lock	ML2053 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 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
3 Silencer	608 / 609		RO

Notes: Latch bolt by lever either side, unless outside lever is locked.
Outside lever locked or unlocked by thumb turn inside. Latch bolt retracted by key when outside lever is locked. Auxiliary latch deadlocks latch bolt.
Inside lever always free for egress.

Set: 55.0

Doors: 010B

6 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Comb. Flush Bolt Set	2845 (HM) / 2945 (WD)	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Magnetic Lock	M62FBD		SU <input type="checkbox"/>
1 Passage Latch	ML2010 NSA M92	626	RU <input type="checkbox"/>
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 4BE CSK	US32D	RO
1 Sound / Smoke Seal	S773D - head and jambs		PE
1 Meeting Edge Seal	S772C x height of door		PE
1 Electric Power Transfer	EL-CEPT		SU <input type="checkbox"/>
1 ElectroLynx Harness	QC-C1500P (power transfer or electric strike to junction box above)		MK <input type="checkbox"/>
1 ElectroLynx Harness	QC-C (power transfer to lock or electric strike location)		MK <input type="checkbox"/>
1 Push Button	PBA		SU <input type="checkbox"/>
1 Power Supply	BPS-24 (amp capacity as required)		SU <input type="checkbox"/>

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: 56.0

Doors: 166AB

3 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Classroom Lock	ML2055 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 4BE 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: 57.0

Doors: 166AA

3 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Classroom Lock	ML2055 NSA 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 4BE 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: 58.0

Doors: 123A

4 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Deadbolt	DL4117 LC	626	RU

1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
1 Pull Plate	BF 111x70B	US32D	RO
1 Push Plate	70F	US32D	RO
1 Surface Closer	DC6200 - pull side mount	689	RU
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
3 Silencer	608 / 609		RO

Notes: Deadbolt thrown or retracted by key outside. Thumbturn inside retracts deadbolt only; will not project deadbolt.

Set: 59.0

Doors: 124A

3 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Deadbolt	DL4117 LC	626	RU
1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
1 Pull Plate	BF 111x70B	US32D	RO
1 Push Plate	70F	US32D	RO
1 Surface Closer	DC6210 A3	689	RU
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO
3 Silencer	608 / 609		RO

Notes: Deadbolt thrown or retracted by key outside. Thumbturn inside retracts deadbolt only; will not project deadbolt.

Set: 60.0

Doors: 132H, 335B

3 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Pull Plate	BF 111x70B	US32D	RO
1 Push Plate	70F	US32D	RO
1 Surface Closer	DC6200 - pull side mount	689	RU
1 Kick Plate	K1050 10" high 4BE 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

Set: 61.0

Doors: 250A

4 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Pull Plate	BF 111x70B	US32D	RO
1 Push Plate	70F	US32D	RO
1 Surface Closer	DC6210 A3	689	RU
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1 Wall Stop	406	US32D	RO

Set: 62.0

Doors: 150CC

4 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Pull Plate	BF 111x70B	US32D	RO
1 Push Plate	70F	US32D	RO
1 Surface Closer	DC6210 A3	689	RU
1 Kick Plate	K1050 10" high 4BE 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

Set: 63.0

Doors: 250B

4 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Pull Plate	BF 111x70B	US32D	RO
1 Push Plate	70F	US32D	RO
1 Surface Closer	DC6210 A4	689	RU
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO

Set: 64.0

Doors: 150AB, 150BB, 150CB

4 Hinge (heavy weight)	T4A3786 / T4A4786	US26D	MK
1 Pull Plate	BF 111x70B	US32D	RO
1 Push Plate	70F	US32D	RO
1 Surface Closer	DC6210 A4	689	RU
1 Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1 Sound / Smoke Seal	S773D - head and jambs		PE
1 Conc. Auto. Door Bottom	420APKL		PE

Set: 65.0

Doors: 126A

2 Continuous Hinge	HG305 x AS	630	MR
2 Flush Bolt	555 / 557	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	ML2057 NSA LC	626	RU
1 Mort. Cylinder	- match Owner's existing Best key system	626	BE
1 Surf Overhead Hold Open	9-X26	652	RF
1 Surface Closer	DC6210 A5	689	RU
2 Armor Plate	K1050 36" high 4BE CSK	US32D	RO
2 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: 66.0

Doors: 185B

2 Continuous Hinge	HG305 x AS	630	MR
2 Pull Plate	BF 111x70B	US32D	RO
2 Push Plate	70F	US32D	RO
2 Surf Overhead Hold Open	9-X26	652	RF
2 Surface Closer	DC6220 top jamb x mounting plate to suit application	689	RU
2 Armor Plate	K1050 36" high 4BE CSK	US32D	RO
2 Silencer	608 / 609		RO

END OF SECTION 087100

SECTION 087900 OPERATOR SWITCH BOLLARDS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manufactured metal bollards for mounting door operator switches and other access control equipment (DR BOL).
- B. Related Sections:
 - 1. Section 055000 - Metal Fabrications: Fabricated steel channel or tube bollards.
 - 2. Section 057000 - Ornamental Metal: Fabricated stainless steel channel or tube bollard.

1.2 COORDINATION

- A. Bollards for Access Control Hardware: Coordinate with Work of the following Sections for access equipment, conduit and connection requirements, and installation coordination.
 - 1. Section 033000 - Cast-In-Place Concrete
 - 2. Section 084229 - Automatic Entrances.
 - 3. Section 087100 - Door Hardware
 - 4. Section 087113 - Automatic Door Operators
 - 5. Division 28 - Electronic Safety and Security
 - 6. Division 32 - Sitework Concrete

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments, hardware and other components.
 - 1. Include diagrams for power and control wiring, and for electronic access controls.
 - 2. Indicate special tolerances and erection requirements.
- C. Samples: For each exposed metal type and finish, 6 inches by 6 inches.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. Products and Manufacturers: Subject to specified requirements, provide Basis of Design or approved equivalent product by one of the listed manufacturers.
 - 1. brp by bison
 - 2. Canterbury International
 - 3. Columbia Cascade Company
 - 4. Creative Pipe, Inc.
 - 5. Dero Bike Rack Co.
 - 6. DuMor Inc.
 - 7. FairWeather Site Furnishings
 - 8. Huntco Supply, LLC
 - 9. Keystone Ridge Designs, Inc.
 - 10. L. A. Steelcraft Products.
 - 11. Maglin Site Furniture Inc.
 - 12. Thomas Steele
 - 13. Urban Accessories, Inc.
 - 14. Victor Stanley, Inc.
 - 15. Wikk Industries.

2.2 BOLLARDS FOR ACCESS CONTROL EQUIPMENT

- A. (DR BOL-1) Bollard for Access Control Equipment: Manufactured metal bollards for surface-mounted door actuators, card-readers and other access control equipment. Provide bollards with cutouts to accommodate conduit and wiring.
1. Basis of Design: _____
 2. Shape: [Square] [Rectangle] [Round].
 3. Size: ___ inches by ___ inches.
 4. Height: [As shown on Drawings] [42 inches exposed, 12 inches recessed in ground, 54 inches total height.]
 5. Aluminum: [**Extruded aluminum bars, profiles or tube, ASTM B 221**] [**Structural aluminum pipe or tube, ASTM B 429**], alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes.
- B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
1. Color: Black, as selected by Architect from full range of industry colors and color densities].
- C. Mounting Type: [**Surface flange anchored at finished grade to substrate indicated**] [**Surface flange anchored below finished grade to substrate indicated**] [**Bolted to embedded anchor bolts**] [**Cast in concrete slab**].
1. Surface-Mounted: Fabricate bollards with 3/8-inch- thick baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.
 - a. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.
 2. Embedded: Fabricate embedded bollards as shown on Drawings. Coordinate with Section 033000 - Cast-In-Place and Concrete or Section 321313 - Sitework Concrete.

2.3 INSTALLATION ACCESSORIES

- A. Installation Accessories: Provide all accessories necessary for complete installation of bollards.
- B. Anchors, Fasteners, Fittings, and Hardware: [**Stainless steel**] [**Galvanized steel**] [**Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials**].
- C. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107; recommended in writing by manufacturer, for exterior applications.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine site conditions, with Installer present, 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.

3.2 INSTALLATION

- A. Anchor bollards with [**expansion anchors**] [**anchor bolts**] [**through bolts**]. Provide four 3/4-inch bolts at each bollard unless otherwise indicated.
1. Embed anchor bolts at least 4 inches in concrete.
- B. Anchor bollards in concrete [**with pipe sleeves preset and anchored into concrete**] [**in formed or core-drilled holes not less than 8 inches deep and 3/4 inch larger than bollard**]. Fill annular space around bollard solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

- C. 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.

END OF SECTION

SECTION 088000 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-17), (GL-18) and (GL-20).
 - 4. Insulating laminated glass (GL-21) and (GL-22).
 - 5. Unframed mirrors (GL-91).
 - 6. Glazing accessories.

1.2 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. Calculations: Structural design shall be performed by a Professional Engineer, licensed in the state where Project is located. Signed engineering calculations shall be submitted to Architect/Engineer
 - 1. Structural design calculations are required per IBC Section 2403, for glass not supported on 4 sides, including glass supports and framing, indicating structural integrity of glass size, glass support members, anchors, fasteners and connections to building, in accordance with specified criteria.
 - 2. Structural design calculations for seismic design forces and relative displacements are required for glass in glazed curtain walls, glazed storefronts and glazed partitions in accordance with Section 017325.
 - 3. Engineering Responsibility: Calculations shall be reviewed for stated design assumptions, general compliance to specified requirements, and forces imposed on glass structure. The accuracy of the design calculations shall be the sole responsibility of the Contractor's Professional Engineer.

1.3 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.

1.4 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.
- C. 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.
 - 4. Obtain Architect's approval of mockups before starting fabrication.
 - 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 6. Demolish and remove mockups when directed.

1.1 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.

1.2 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.

1.3 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.

1.4 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. 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.
- C. 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. 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.
 3. 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.
 4. Minimum Glass Thickness for Exterior Lites: Not less than 6 mm.
 5. 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 .
 5. Center-of-Glass Solar Heat Gain Coefficient: NFRC 200 methodology using LBL-35298 WINDOW 4.1 computer program.
 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. AFG Industries.
 - 2. ACH.
 - 3. Guardian Industries Corp..
 - 4. Pilkington North America, Inc..
 - 5. Viracon.
 - 6. Vitro Architectural Glass (formerly PPG).
- C. Fabricators for Insulating Glass Units: Refer to Basis of Design in Part 2.
- D. Fabricators for Specialty Glass and Specialty Glass Units: As specified with individual glass type descriptions.

2.3 MONOLITHIC GLASS

- 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. (GL-1) Clear Float Glass: 1/4-inch; ASTM C1036, Type I (transparent glass, flat), Class 1 (clear), Quality-Q3 (glazing select).
- C. (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).
- D. (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).
- E. (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.
 - 3. Basis of Design: Amiran Low-Iron Glass by Schott North America, Inc.

2.4 LAMINATED GLASS

- A. 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.

- B. (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" clear PVB Interlayer.

2.5 INSULATING GLASS UNITS

- A. 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.
 - a. Provide safety glazing labeling, as applicable.
 4. Desiccant: Molecular sieve or silica gel, or blend of both.
 5. Dual Seal: Provide Manufacturer's standard silicone and polyisobutylene dual sealing system. Provide black colored silicone, unless noted otherwise.
 6. Spacer:
 - a. Aluminum, finish as specified below.
 - b. Stainless Steel
 - c. Viracon ExtremEdge warm edge spacer.
 7. Glass type locations as indicated on Drawings.
- B. Basis of Design for Insulated Glass Types: Provide materials obtained from one source for each type of insulating glass and glazing product indicated.
1. Basis of Design Warm-Edge Spacer: 17/32 inch actual thickness.
 2. Product and Manufacturer: Solarscreen VNE 1-63 by Viracon, Inc..
 - a. Visible Transmittance: 62 percent.
 - b. Ultraviolet Transmission: 5 percent.
 - c. Nighttime Winter U-value: 0.25
 - d. Solar Heat Gain Coefficient: 0.28
 3. Other Product and Manufacturer: Solarban 70XL on Starphire glass, by Oldcastle Glass.
 - a. Visible transmittance: 64 percent.
 - b. Ultraviolet Transmission: 6 percent.
 - c. Nighttime Winter U-value: 0.28
 - d. Solar Heat Gain Coefficient: 0.27
- C. (GL-21) Insulating Vision Glass:
1. Glazing Unit Thickness: 1 inch.
 2. Outboard Lite: 1/4 inch, clear; heat-treated.
 - a. High-performance low-emissivity coating applied to No. 2 surface.
 3. Airspace: 1/2 inch, argon-filled, with black painted stainless steel spacer..
 4. Inboard Lite: 1/4 inch, clear; heat-treated.
- D. (GL-21T) Insulating Vision Glass, Fully-Tempered:
1. Glazing Unit Thickness: 1 inch.
 2. Outboard Lite: 1/4-inch, clear; fully-tempered
 - a. High-performance low-emissivity coating applied to No. 2 surface.
 3. Airspace: 1/2 inch, argon-filled, with black painted stainless steel spacer.
 4. Inboard Lite: 1/4 inch, clear; fully-tempered.

2.6 MIRRORS

- A. Glass Mirrors, General: ASTM C 1503; manufactured using copper-free, low-lead mirror coating process.
- B. (GL-91) Clear Unframed Glass Mirrors: 1/4" thick; ASTM C1503, Mirror Select Glazing Quality. Provide 5 year warranty.
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.

2.7 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 preshimmied tape similar to Tremco 440 Tape.

2.8 GLAZING TAPES

- A. Back-Bedding 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.
- B. 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.
- C. 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.

2.9 GLAZING SEALANTS

- A. 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 preconstruction 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 material 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.
- B. 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.
 4. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.

- C. 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.
- D. 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
- E. 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
- F. Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT, G, and A.
 - 1. Basis of Design Product: Dow Corning Corporation, 999-A Silicone Building & Glazing Sealant.

2.10 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 of metal finish required.

1.3 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2, "Structural Welding Code - Aluminum."
 - 2. AWS D1.3, "Structural Welding Code - Sheet Steel."
 - 3. AWS D1.6, "Structural Welding Code - Stainless 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.
- B. SMACNA Standard: Comply with SMACNA Architectural Sheet Metal Manual recommendations for fabrication, construction details, and installation procedures.
- 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.
- H. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
- I. Subject to compliance with specified requirement, provide Basis of Design or provide equivalent products by one of the following:
 - 1. Airo-lite Company
 - 2. Construction Specialties, Inc.
 - 3. Greenheck Fan Corporation
 - 4. Industrial Louvers, Inc.
 - 5. Nystrom Building Products.
 - 6. Ruskin Company; Tomkins PLC.
- J. (LVR-1) Extruded Aluminum, **Vertical** Blade Louver: Prefinished, shop-assembled, wind-driven-rain-resistant, vertically-oriented drainable-blade louvers.
 - 1. Basis of Design: Type RSV-5700 by Construction Specialties, Inc..
 - 2. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.
 - 3. 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.
 - 4. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: Black, as selected by Architect.

2.2 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.

2.3 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.
 - 2. Load-bearing steel framing systems supporting ACOUST-A and ACOUST-B ceiling types.
- B. Related Sections:
 - 1. Section 018122 - Facility Acoustic Performance Requirements.
 - 2. Section 054000 - Cold-Formed Metal Framing: For interior framing members carrying a lateral (transverse) load exceeding 10 lb/ft², 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.
 - 3. Section 134833 - Sound & Vibration Control: For (SVC) components.

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.
 - 4. Evaluation Reports: ICC-ES reports for metal studs and tracks, indicating compliance with specified requirements and building code in effect.

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.
- B. Calculations: Structural design for metal studs supporting ACOUST-A and ACOUST-B ceiling types shall be performed by a Professional Engineer, licensed in the State of Texas, indicating structural integrity of members, anchors, fasteners and connections to building structure, in accordance with specified criteria. Signed engineering calculations shall be submitted to Architect/Engineer upon request.
 - 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.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with applicable reference standards unless otherwise indicated.

- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Texas and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent
- C. 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).
- E. Studs and Joists Supporting Acoustic Wall and Ceiling Assemblies:
 - 1. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design joists and walls supporting ceiling type ACOUST-A and ACOUST-B.
 - 2. Structural Performance Requirements: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated. Provide in accordance with applicable codes and standards to safely support dead load of attached materials and a lateral unbalanced pressure of 5 pounds per square foot without excessive stress or deflection with following stipulation:
 - a. Metal Studs: Provide metal framings depths indicated in the drawings. Revise spacing and thickness of studs and joists as required to meet the stated load and deflection criteria.
 - 1) Stud Spacing: As required to meeting loading requirements but not over 16 inches on center.
 - 2) Stud Thickness: 33 mil minimum base metal thickness or as required to meet stated load and deflection requirements.
 - 3) Design joists supporting ceilings for a maximum deflection of 1/240th the joist span.
 - b. Bridging: Provide as required for walls that will be sheathed on only one side.
 - c. Lateral Bracing: Provide as required to limit deflection of wall and ceiling assemblies to 1/400th the height of the assembly.
 - d. Attachment to structure: Provide attachments to primary building structure without overload or distortion of metal studs, attachment elements, or building structure.
 - 3. Design light gage framing members in accordance with AISI "Specifications for Design of Cold-Formed Steel Structural Members"

- F. Acoustic Shelf Assembly in Concert Hall: Provide metal framing capable of withstanding design loads within limits and under conditions indicated. Design in accordance with applicable codes and standards to safely support point loads of 200 lbs, without excessive stress or deflection.

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.
 - 3. Steel Sheet Components: ASTM C 645, fabricated of steel meeting requirements of ASTM A1003.
 - 4. Protective Coating (Minimum): ASTM A653, G40 hot-dip galvanized zinc coating or coating with G40 equivalent corrosion resistance.
 - 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.
- E. Sound and Vibration Control Components: See Section 134813 - Manufactured Sound & Vibration Control Components for resilient ceiling hangers, sway braces, wall isolators and similar sound and vibration control components (SVC) for acoustically-critical wall and ceiling assemblies.

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. Sound and Vibration Control Components (SVC): Install in accordance with manufacturer's instructions and as specified in Section 134833.
- E. 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.
 6. Stud Splicing: Not permitted.
- 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.
 - 3. Gypsum assembly accessories (GYPA).

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.
1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory." GA-600, "Fire Resistance Design Manual."
- 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.
 2. Provide products in accordance with recommendations of GA 216 - Application and Finishing of Gypsum Panel Products.
 3. Provide products in maximum lengths and widths available to minimize joints and to correspond with support system indicated.
- B. (GYP BD) Gypsum Wallboard:
1. Acceptable Manufacturer's:
 - a. United States Gypsum.
 - b. National Gypsum Company.
 - c. Georgia-Pacific.
 - d. CertainTeed Corporation.
 - e. 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.
 2. Mold Resistance: ASTM D 3273, score of 10.
 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.
 - 1. Acceptable Manufacturer, Paper Faced: ASTM C1396.
 - a. United States Gypsum Company: SHEETROCK Brand Gypsum Liner Panels.
 - b. National Gypsum Company: Gold Bond Brand Fire-Shield Shaftliner.
 - c. G-P Gypsum Corp.: ToughRock Shaftliner.
 - 2. Acceptable Manufacturer, Moisture and Mold Resistant Paper Faced, ASTM D3273 score of 10:
 - a. United States Gypsum Company: SHEETROCK Brand Mold Tough Gypsum Liner Panels.
 - 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.
 - c. National Gypsum Company: eXP Shaftliner.
 - d. United States Gypsum Company: SHEETROCK Brand Glass-Mat Liner Panels.
- 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:
 - a. National Gypsum Company; Gold Bond Brand Hi-Abuse XP Gypsum Board.
 - b. United States Gypsum Co.; SHEETROCK Brand Mold Tough Abuse-Resistant Firecode X Panels.
 - c. CertainTeed Corp.: AirRenew Extreme Abuse Gypsum Board.
 - 2. ASTM C1629: Surface Abrasion Level 3, Indentation Level 1, Soft Body Impact Level 2.
 - 3. Core: 5/8 inch, Type X.
 - 4. Long Edges: Tapered.

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.
 - 3. Manufacturer: Drywall Systems International No-Coat.
- 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
 - 2. Acoustical Sealant for Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission.
 - 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 VAPOR RETARDERS AND ACCESSORIES

- A. (VR-1) Polyethylene Vapor Retarder: ASTM D 4397, 6 mils thick, with maximum permeance rating of 0.13 perm.
- B. Seam Tape at Vapor Retarders:
 - 1. Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
 - 2. Minimum: 2 inches wide.

2.7 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. Profile Schedule:
 - a. (GYPA-1) 'J' Molding: JDM Series by Fry Reglet.
 - b. (GYPA-2) Corner Trim: DMCT Series by Fry Reglet.
 - c. (GYPA-3) 'Z' Reveal: DRMZ Series by Fry Reglet.
 - d. (GYPA-4) 'F' Reveal: DRMF or FDM Series by Fry Reglet.
 - e. (GYPA-5) Wall Molding End Closure: DMEC-4625 by Fry Reglet.
 - 2. Manufacturers: Provide specified products or equivalent products by one of the following:
 - a. Gordon Incorporated
 - b. Fry Reglet Corporation
 - c. Pittcon Industries
- 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 appendixes. 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
 - 9. Review location of joints with Architect.
- 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 or ends of sheets. 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.
 1. Cementitious Backer Boards: ANSI A108.11.
 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, prefill joints with joint compound and allow prefill 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.
 - 2. Mortar Materials.
 - 3. Grout Materials.
 - 4. Waterproofing and Crack Isolation Membrane
 - 5. Tiling Accessories.
 - 6. Installation Procedures.

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. Refer to Material Identification List for product selections and product information such as colors, finishes, and accessories. General product type and materials information as specified herein.
 - 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. Custom Building Products.
 - 2. LATICRETE International Inc..
 - 3. 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.
- C. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
 - 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 Materials:
 - 1. Water-Cleanable, Tile-Setting and -Grouting Epoxy: ANSI A118.3.
 - 2. Chemical-Resistant, Water-Cleanable, Tile-Setting and -Grouting Epoxy: ANSI A118.3.
 - 3. Color: As selected by Architect from manufacturer's full range to match tile.
- G. Grout Sealer: Provide grout sealer compatible with grout materials as recommended by grout manufacturer.
- H. Sanded Polymer-Modified Portland Cement Grout: ANSI A118.6 and ANSI 118.7; and meeting the requirements of ISO 13007 Classification CG2WAF.
 - 1. Product and Manufacturer: Ultracolor Plus by Mapei.
 - 2. Use sanded polymer-modified cement grout for setting (CTF-1), (CTF-2), and (CFT-3).
 - 3. Color: Custom colors as selected by Architect.

2.3 ACCESSORIES

- A. (CTA) Ceramic Tile Trim and Transition Strips:
 - 1. Basis of Design: As indicated on Material Identification List.
- 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
 - b. Hydro Ban by Laticrete International, Inc..
 - c. Mapelastic AquaDefense by Mapei Corporation.
 - 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. Solid Polymer Thresholds: Made from homogeneous solid sheets of filled plastic resin complying with material and performance requirements in ANSI Z124.3, for Type 5 or Type 6, without pre-coated finish. Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
 - 1. Basis of Design: As indicated on Material Identification List.
- D. 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.
- E. 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:
 - 1. Acoustical panel ceilings and exposed suspension system (ACT).
 - 2. Acoustical panel perimeter trim (ACTR).

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.
 - 4. Minimum Drawing Scale: 1/8 inch equals 1 foot.
- 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. Ecophon CertainTeed, Inc.;
 - 4. Chicago Metallic Corporation;
- B. (ACT) Basis-of-Design: As indicated on the Material Identification List.

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.
 - a. Structural Classification: Intermediate-duty system.
 - 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 time 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.

1. Flexible Moldings: Flexmold steel and vinyl flex moldings by Kenebeck, white semi-gloss finish.
 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. (ACTR-1) Basis of Design: Axiom by Armstrong. See Material Identification List for more information.
 2. 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.
 3. 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 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

- A. (TRS) Flooring Transition Strips: As indicated on Material Identification List.

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: Field-finished hardwood strip flooring systems (WDF-1) and (WDF-2).

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: Approximately 18 inches by 18 inches, constructed of hardwood strips of specified type, thickness, width and finish, demonstrating the full range of expected color and texture variations.
 - 1. Coordinate with Section 064000 for submittal of samples for concurrent review of materials by Architect.
 - 2. Flooring System Cutaway Sample: For (WDF), 12 inches square (minimum), including all flooring system 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. WDF-1: Hardwood flooring over subfloor; 2-1/4"w x 3/4" T&G rift-cut white oak WD-1 strips, field-finished; 1 layer 3/4" T&G plywood, wood 2x4 sleepers, resilient isolation pads, vapor barrier
- B. WDF-2: Hardboard panel flooring over subfloor; 1 layer 1/4" tempered hardboard, 1 layer 3/4" T&G plywood, 1 layer 3/4" plywood, wood 2x4 sleepers, resilient isolation pads, vapor barrier (over slab-on-grade)
- C. WDF-3: Hardboard panel flooring over subfloor; 1 layer 1/4" tempered hardboard, 1 layer 3/4" T&G plywood, 1 layer 3/4" plywood, wood 2x4 sleepers, resilient isolation pads (over elevated slab)

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: White oak, quarter sawn, stain and transparent finish to match WD-1 as specified in Section 064000.
 - 2. Profile: Tongue and groove.
 - 3. Face Width: 2-1/4 inches.
 - 4. Thickness: 3/4 inch.
 - 5. Lengths: Random-length strips complying with applicable grading rules.
 - 6. Finish: Urethane finish system.
- B. Urethane Finish System: Complete water-based system of compatible components that is recommended by finish manufacturer for application indicated.
 - 1. Finish Coats: Formulated for multi-coat application on wood flooring.
 - 2. Manufacturers:
 - a. Basic Coatings, Inc.
 - b. BonaKemi USA Inc.;
 - c. Dura Seal, Sherwin-Williams Company;
 - 3. 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.
 - 4. Stain: Penetrating and nonfading type, matching Architect's sample for (WD-1).
 - 5. Floor Sealer: Pliable, penetrating type.
- C. Plywood Subfloor: Tongue and groove, Group 1, EXT-APA B-B, with special solid jointed core construction (B-Grade); installed with staggered joints.

- D. Building Paper Slip Sheet: Red-rosin type building paper, 3 lb/100 sq. ft. minimum weight.
- E. Sleepers: Douglas Fir, WCLA, kiln-dried, S4S, preservative treated with Dry-Vac treatment, with resilient pads attached to bottom side. Use where indicated at wood flooring.
- F. Vapor Barrier:
 1. Basis of Design: VersaShield MBX by GCP Applied Technologies.
 2. Water Vapor Permeance: 0.05 maximum grain $\text{h}^{-1} \text{ft}^{-2} \text{inHg}^{-1}$ per ASTM E96.
 3. Thickness: 28 mils.

2.4 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by wood flooring manufacturer.
- 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. 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. Tramex Concrete Moisture Encounter: 4.5 percent maximum moisture reading on the upper scale.
 2. Polyfilm Tests: Apply a 36-inch square piece of polyethylene film to concrete and seal perimeter with moisture resistant tape. Let sit undisturbed for 24 hours. If concrete has darkened or condensation has developed upon examination after 24 hours, perform tests in accordance with ASTM F 1869 Calcium Chloride or ASTM F2170 In-situ method.
 3. 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.
 4. 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.
 5. Perform additional moisture tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

- D. 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. Cover wood flooring before finishing.
- 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. (RFT) Linoleum Floor Tile: ASTM F 2195, Type II, linoleum floor tile with special backing.
 - 1. Basis of Design: As indicated on Material Identification Codes List.
- C. (RSF) Linoleum Sheet Flooring: ASTM F 2034, Type III, linoleum sheet with special backing.
 - 1. Basis of Design: As indicated on Material Identification Codes List.
- D. (RB) Rubber Wall Base: ASTM F 1861, Type TS, Group 1, Styles A and B. Provide in 120-foot long rolls. Provide standard top-set cove base, except provide straight base at carpet.
 - 1. Basis of Design: As indicated on Material Identification Codes List.
 - 2. ASTM E 84; Class B rating with smoke density of 150-200.
- E. (RTS) Resilient Floor Finish Transition Strips:
 - 1. Basis of Design: As indicated on Material Identification Codes List.

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. Waterproof resinous flooring system (RES-1).
 - 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.
 - 8. Rust-Oleum Corporation.
 - 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 WATERPROOF RESINOUS FLOORING SYSTEMS

- A. (RES-1) Waterproof Resinous Flooring: Trowel-applied, multi-layer, seamless, waterproofing flooring system consisting of waterproof membrane and waterproof base reinforced with embedded polypropylene mesh fabric with integral cove base and finish coat of a pigmented acrylic topping. Provide slip resistance surface meeting local code requirements.
 - 1. Basis of Design: Dex-O-Tex M-E Floor waterproofing by Crossfield Products Corporation.
 - 2. Configuration:
 - a. Color: Manufacturer's standard color as selected by Architect.
 - b. Thickness: 3/32 inch.
 - c. Base: Integral cove bases.
 - 3. Performance Requirements:
 - a. Water Transmission Resistance: Sample subjected to 50 pounds per inch water pressure for 60 minutes: No transmission.
 - b. Microbial Resistance (ASTM G21): Passes
 - c. Flammability (ASTM D635): Self-Extinguishing Bonded to Concrete.

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.
 - 4. Strip all concrete cracks, construction joints with 10 inch wide elastomeric membrane with polypropylene fabric reinforcing.
- 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.
1. Self-Leveling Body Coats: Apply self-leveling slurry body coats in thickness indicated for flooring system.
 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 (CPT-__).
2. Sheet carpet (CPT-__).
3. 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.
4. Carpet Cushion: 6-inch- square Sample.
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 CLOSEOUTSUBMITTALS

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.
 1. Surface Flammability: Passes CPSC 16 CFR, Part 1630.
 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 Identification List.

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.
 - 2. Adhesive and Sealant VOC Limits: According to South Coast Air Quality Management District Rule 1168 and GS-36 for aerosols. VOC Limits: As tested using U.S. EPA Reference Test Method 24 and as defined by South Coast Air Quality Management District Rules: SCAQMD Rule 1168, Adhesive and Sealant Applications.
- 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.
 - 3. Vacuum carpet using commercial machine with face-beater element.
- B. Protection: Protect installed carpet to comply with CRI's "CRI Carpet Installation Standard."

END OF SECTION

SECTION 097200 WALL COVERINGS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes :Vinyl wall covering with custom graphics (VWC-1).

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include data on physical characteristics, durability, fade resistance, and flame-resistance characteristics.
- B. Shop Drawings: Show location and extent of each wall-covering type.
 - 1. Indicate pattern placement, seams and termination points.
- C. Samples: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by 36-inches long.
 - 1. Wall-Covering Sample: From same production run to be used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of fabric.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Schedule: For wall coverings.
- B. Maintenance Data: For wall coverings to include in maintenance manuals.

1.4 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.

1.5 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.
 - 1. Store in a cool, dry place out of direct sunlight.
 - 2. Protect from damage by the elements and construction procedures.
 - 3. Store at temperature above 40 degrees F.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings 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.
- B. Lighting: Do not install wall covering until a permanent level of lighting is provided on the surfaces to receive wall covering.
- C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

1.7 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. Wall-Covering Materials: For each type, full-size units equal to [5] percent of amount installed.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Surface-Burning Characteristics: As follows, per ASTM E 84:
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 2. Fire-Growth Contribution: Textile wall coverings tested according to NFPA 265 and complying with Method A test protocol in IBC 2000, Section 803.5.1.

2.2 VINYL WALL COVERING

- A. Products and Manufacturers: Subject to compliance with specified requirements, provide Basis of Design or equivalent product, as approved by Architect.
 1. Basis of Design: As indicated on Material Identification List on Drawings.

2.3 INSTALLATION ACCESSORIES

- A. Adhesive: Mildew-resistant, non-staining adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.
 1. Adhesive shall have a VOC content of 50 g/L or less.
- B. Primer/Sealer: Mildew resistant, complying with requirements in Section 099000 - Painting and recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.
- C. Seam Tape: As recommended in writing by wall-covering manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for levelness, wall plumbness, maximum moisture content, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Schedule installation of wall covering at appropriate time during progress of work to prevent damage during construction and movement of materials.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.
- C. Fill seams, joints, nicks, gouges and other minor imperfections of substrate wall surfaces with latex block filler. Sand smooth flush with surface.
 1. Follow with prime coat of sealer recommended by wall covering manufacturer.
- D. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
 1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
 2. Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.

3. Metals: If not factory primed, clean and apply metal as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
 4. Gypsum Board Substrate:
 - a. Tape and sand gypsum board assemblies in accordance with Section 092900 – Gypsum Board to achieve smooth and flat substrate for cork wall covering.
 - b. Prime gypsum board surfaces receiving wall covering as recommended by manufacturer.
 5. Painted Surfaces: Treat areas susceptible to pigment bleeding.
- E. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.
 - F. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.
 - G. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.3 WALL-COVERING INSTALLATION

- A. General: Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated except where more stringent requirements apply.
- B. Cut wall-covering strips in roll number sequence. Change roll numbers at partition breaks and corners.
- C. Install strips in same order as cut from roll.
 1. For solid-color, even-texture, or random-match wall coverings, reverse every other strip.
- D. Install wall covering with no gaps or overlaps, no lifted or curling edges, and no visible shrinkage.
- E. Install seams vertical and plumb at least 6 inches from outside corners and **[3 inches] [6 inches]** from inside corners unless a change of pattern or color exists at corner. No horizontal seams are permitted.
- F. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.
- G. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without any overlay or spacing between strips.

3.4 CLEANING

- A. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.
- B. Use cleaning methods recommended in writing by wall-covering manufacturer.
- C. Replace strips that cannot be cleaned.
- D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

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.
 - 2. Maintenance Manual.
- 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..
- B. (FRP-1) Fiberglass-Reinforced Panels: Gelcoat-finished, glass-fiber reinforced plastic panels complying with ASTM D 5319.
 - 1. Basis of Design: Refer to Material Identification List.
 - 2. Nominal Thickness: 0.090 inch.
 - 3. Panel Finish: Smooth or Embossed (Pebble Texture) as selected by Architect.
 - 4. Color: White.

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) and (AST-2).
 - 2. Surface-applied sound-absorbing insulation panel (AST11) thru (AST-14).

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. Direct-Applied Insulation (AST-4) and (AST-5): Submit two samples, 12 inches by 12 inches.

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 (2) ceiling panels (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.
3. Maintain mock-ups during construction in an undisturbed condition as standard for judging completed Work.

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. 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:
 - a. Acoustical performance.
 - 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 Designscape.
 3. Decoustics Limited.
 4. Kinetics Noise Control, Inc..
 5. RPG Inc..
 6. Wall Technology, Inc.

- B. (AST-1) Fabric-Wrapped, Tackable Wall Panels: Fixed panels consisting of acoustically-transparent fabric facing stretched over sound-absorbing core panel with tackable facer.
 - 1. Basis of Design: AP by Decoustics.
 - 2. Thickness: 1-inch.
 - 3. Fabric Facing: As indicated on Material Identification List.
 - 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. (AST-2a) and (AST-2b) Fabric--Wrapped Panels, Impact-Resistant: Fixed panels consisting of acoustically-transparent fabric facing stretched over sound-absorbing core panel.
 - 1. Basis of Design: HIR by Decoustics.
 - 2. Thickness: 2-inch.
 - 3. Fabric Facing: As indicated on Material Identification List.
 - 4. 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.
 - 5. Impact-Resistant, Acoustically Transparent, Copolymer Sheet for Face Layer: 1/16- to 1/8-inch- thick layer of perforated, noncombustible, copolymer sheet laminated to face of core.
 - 6. Attachment: Back-mounted with manufacturer's standard metal clips for ceiling mounting.
- D. 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 SURFACE-APPLIED ACOUSTIC INSULATION

- A. (AST-11) (AST-12) (AST-13) (AST-14)) 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.
 - 3. Nominal Density: 3 lb/cu. ft..
 - 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).

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 FABRIC-WRAPPED 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 099000 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 MAINTENANCE MATERIAL SUBMITTALS

- A. 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. Job Site Sample Areas: Make sample application of high performance epoxy coating on project surfaces to the extent of one system on one wall of one room 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.

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. Approved Manufacturer: Benjamin Moore Paints.
- 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.
 - 6. Zinc-Rich Industrial Maintenance Primers: 340 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) and (PTE) Paint Colors: Provide specified color in paint type as scheduled in this Section
 1. Refer to Material Identification List for color selections.

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.
 3. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather out edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Prime steel including shop primed steels.
- 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 brush, roller, 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, convector 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, convector 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.
 - 2. Waterborne System (Low-VOC): Waterborne Acrylic Gloss Enamel over Waterborne Metal Primer.
 - a. Primer: 1 coat Direct to Metal Primer and Flat Finish (or 1 coat touch-up if preprimed).
 - b. Finish: 2 coats High Performance Waterborne Acrylic Semi-Gloss Enamel #4216HP Series.
- 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.

2. Waterborne System (Low-VOC): Waterborne Acrylic Gloss Enamel over Waterborne Metal Primer.
 - a. Primer: 1 coat Direct to Metal Primer and Flat Finish (or 1 coat touch-up if preprimed).
 - b. Finish: 2 coats High Performance Waterborne Acrylic Semi-Gloss Enamel.
- 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.
 - b. Finish: 2 coats Exterior Acrylic Satin Finish.

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, convectector 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.
 2. Waterborne Zero VOC, Low Odor System: Acrylic over Waterborne Metal Primer.
 - 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).
 2. Waterborne Zero VOC, Low Odor System: Acrylic Finish over Acrylic Primer.
 - 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
 - 2. Waterborne Zero VOC, Low Odor System: Acrylic Finish over Acrylic Latex Wood Undercoater.
 - 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.
 - 2. Water Based Systems (Low-VOC): Acrylic Latex Finish.
 - 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.
 - 2. Waterborne System: Premium Quality Acrylic Latex finish over -Acrylic Primer.
 - 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 099600 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.
 - 5. Zinc-Rich Industrial Maintenance Primers: 340 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 Steel, Non-Galvanized: 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.
 - 2. System: Zinc-rich primer, epoxy build-coats, urethane finish.
 - 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.
 - 2. System: Zinc-rich urethane base, water-based epoxy build coat, polyurethane finish.
 - a. Primer: Series 94-H₂O Hydro-Zinc by Tnemec.
 - 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 101100 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 MARKERBOARDS

- A. Manufacturers:
 - 1. Claridge Products.
 - 2. PolyVision,
 - 3. ADP Lemco Incorporated.

- B. (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. Basis of Design: Series 110 by PolyVision Corporation.
 - 2. 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.
 - 3. Manufacturer's Standard Core: Minimum 1/4 inch thick, with manufacturer's standard moisture-barrier backing.
 - 4. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.
 - 5. Extruded Aluminum: ASTM B 221, Alloy 6063; clear anodic finish, AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

2.2 TACKBOARDS

- A. Manufacturers:
 - 1. PolyVision,
 - 2. ADP Lemco Incorporated.
- B. (TKBD-1) Sealed Composition Cork: 1/4 inch thick seamless sheet bulletin board cork with washable vinyl finish, of composition cork compressed with resinous binder and integral color throughout entire thickness and laminated to burlap backing.
 - 1. Flame Spread Rating: Complying with ASTM E84, with flame spread rating of 65.
 - 2. Color: See Material Identification List.
- C. Extruded Aluminum J-Trim: ASTM B 221, Alloy 6063; clear anodic finish, AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

2.3 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.

2.4 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.

2.5 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.

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-3).

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.
 - 3. Bradley Corporation.
 - 4. Scranton Products.

2.3 SOLID-PLASTIC TOILET COMPARTMENTS

- A. (T COMP-3) Basis of Design: Floor-mounted, overhead-braced solid plastic toilet enclosures and wall-hung urinal screens.
 - 1. Basis of Design: FP-500 Corinthian by Metpar Steel Products; with Type WH urinal screens.
 - 2. Other Products:
 - a. Solid High-Density Polyethylene (HDPE): Hiney-Hiders Poly-Mar HD by Scranton Products.

- b. Solid Color Reinforced Composite (SCRC): Sierra Series by Bobrick.
- 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. Color and Pattern: One color and pattern as selected by Architect from manufacturer's full range.
- 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 sex 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.
 - 3. Provide for adjustment for floor variations with screw jack through steel saddles integral with pilaster. Conceal floor fastenings with stainless steel shoes.
 - 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 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 METAL WALL CORNER GUARDS

- A. Manufacturers:
 - 1. Koroguard.
 - 2. Wilkinson Company.
 - 3. MM Systems Corp.
 - 4. K.J.Miller Corp.
 - 5. Stylmark
 - 6. C/S Group.
- B. (WCG-4) 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. Material: **Stainless-steel sheet**, [Type 304] [Type 430].
 - a. Thickness: Minimum [0.0500 inch] [0.0625 inch] [0.0781 inch].
 - b. Finish: [Directional satin, No. 4] [Bright annealed].
 - 2. Wing Size: Nominal [1-1/2 by 1-1/2 inches] [2-1/2 by 2-1/2 inches] [3-1/2 by 3-1/2 inches].
 - 3. Corner Radius: [1/8 inch] [3/4 inch].
 - 4. Mounting: [Flat-head, countersunk screws through factory-drilled mounting holes] [Oval head, countersunk screws through factory-drilled mounting holes] [Adhesive].

2.2 ACCESSORIES

- A. Attachment Hardware: As recommended by manufacturer for wall construction type.
- B. Aluminum Retainers: Extruded 6063-T6 alloy aluminum retainers. Minimum strength and durability properties complying with ASTM B221.
- 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.
 - 1. *Complete finishing operations, including painting, before beginning installation of wall surface protection system materials.*
- 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 102813 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 (OFCl).
- 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

2.1 PRODUCT REQUIREMENTS

- A. Product Options: Accessory requirements, including those for materials, finishes, dimensions, capacities, and performance, are established by specified Basis of Design products.
 - 1. Products of other manufacturers listed in Part 2 with equal characteristics, as judged solely by Architect, may be provided.
 - 2. Do not modify aesthetic effects, as judged solely by Architect, except with Architect's approval. Where modifications are proposed, submit comprehensive explanatory data to Architect for review.
- B. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.
- 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. Basis of Design: Subject to compliance with requirements, provide accessories by one of the following:
 - 1. Washroom Equipment:
 - a. Bobrick Washroom Equipment Inc.
 - b. American Specialties Inc.
 - c. Bradley Corporation
 - d. GAMCO
 - e. Tork
 - 2. Warm-Air Dryers:
 - a. Bobrick Washroom Equipment, Inc.
 - b. Excel Dryer Corporation.
 - c. World Dryer.

2.2 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).
- F. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.
- 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.
 - 3. Galvanized Steel Mounting Devices: ASTM A 153, hot-dip galvanized after fabrication
- 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.

2.3 GENERAL ACCESSORIES

- A. (BA-1) Mop and Broom Holder with Shelf: 3 holders, 36 inches long.
 - 1. Product and Manufacturer: No.9983 by Bradley.
- B. (CH-1) Coat Hook: Single Prong Robe Hook, Matte Nickel.
 - 1. Product and Manufacturer: No.B59103Z-SN-C by Liberty Hardware.
- C. (CH-2) Hat and Coat Hook:
 - 1. Product and Manufacturer: No.9134 by Bradley.

2.4 WASHROOM ACCESSORIES

- A. (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.
- B. (MIR-1) Framed Mirrors Without Shelf: sizes as indicated.
 - 1. Product and Manufacturer: B-290 Series by Bobrick.
- C. (PTC-1) Paper Towel Roll Dispensers: Surface-mounted, ABS plastic, black..
 - 1. Product and Manufacturer: No.5510282 by Tork.
- D. Paper Towel Dispensers and Waste Receptacles: Dispenses C-fold, multifold and single fold. Surface mounted, stainless steel.
 - 1. Product and Manufacturer: B-39003 by Bobrick.
- E. Paper Towel Dispensers and Waste Receptacles: with stainless steel skirt for surface mounting; Dispenses C-fold, multifold and single fold. Surface mounted, stainless steel.
 - 1. Product and Manufacturer: B-390039 by Bobrick.
- F. Paper Towel Dispenser: Singlefold only, stainless steel.
 - 1. Product and Manufacturer: Continental Mfg.Co. #630C
- G. (SDISP-1) Soap Dispenser: Surface-mounted, ABS plastic, black.
 - 1. Product and Manufacturer: No.570028A Elevation Liquid Soap Dispenser by Tork.
- H. Soap Dispensers: Plastic hand soap dispensers with mounting holes. The dispensers will receive prepackaged 800 ml liquid soap cartons and may take 1000 ml cartons.
 - 1. Product and Manufacturer: Johnson Soft Care Elite System [DermaCare Hand Care]
- I. (SNC-2) Sanitary Napkin/Tampon Dispensers: 50 cent operation, recessed mounted.
 - 1. Product and Manufacturer: B-3706 by Bobrick.

- J. (SND-2) Sanitary Napkin Disposal: Surface-mounted, stainless steel.
 - 1. Product and Manufacturer: B-245 by Bobrick.
- K. (TPH-1) Toilet Paper Holder: Surface-mounted, roll-in-reserve dispenser, ABS plastic, black.
 - 1. Product and Manufacturer: No.55TR by Tork.
- L. Water Closet Tissue Dispenser: Enclosed Box Type.
 - 1. Product and Manufacturer: Bobrick #B-3888 Contura Multi-roll with plated steel dispensing mechanism for recessed areas
 - 2. Product and Manufacturer: Bobrick #B-2888 Contura Multi-roll with plated steel dispensing mechanism for surface mount areas
- M. Water Closet Tissue Dispenser: Single open roll type.
 - 1. Product and Manufacturer: Palmer Fixture Company #TP-202 Single Holder Hinged roller pin, security roller, noncontrolled delivery, surface mount. Mount two single fixtures per stall
 - 2. Product and Manufacturer: Bobrick #B-2730 Removable, security pin, non controlled delivery. Mount two single fixtures per stall
- N. (WRC-1) Waste Receptacle: Stainless steel recessed frame and waste receptacle.
 - 1. Product and Manufacturer: No.309051 H1 System by Tork..

2.5 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.
 - 2. Heavy-duty wall brackets of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
- 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 ADJUSTING AND CLEANING

- 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 104400 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. JL Industries
 - 2. Larsen's Manufacturing
 - 3. Potter Roemer, Div. of Smith Industries, Inc.
 - 4. Kidde Fyrnetics.
 - 5. Nystrom Building Products.

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.
 - a. Basis of Design: Cosmic 5E by JL Industries.
- 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.
 - 1. Color: Black.

2.4 FIRE EXTINGUISHER CABINETS

- A. (FEC-1) Recessed Steel Cabinet with Flat Trim:
 - 1. Basis of Design: Ambassador Series 1015F17 by JL Industries.
 - 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:
 - 1. Basis of Design: Ambassador Series 1013F17 by JL Industries.
 - 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 105113 METAL LOCKERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Welded metal locker units with hinged doors (LKR-1).
 - 2. Base, top and filler panels.
 - 3. Hooks, latches, and hardware.
 - 4. Attachment hardware.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of metal locker.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker and bench.
- B. Shop Drawings: For metal lockers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Show locker trim and accessories.
 - 3. Include locker identification system and numbering sequence.
- C. Samples: For each exposed finish type..

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Engage experienced Installer who is authorized representative of metal locker manufacturer for installation of type of lockers required for this Project.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Do not deliver lockers until spaces to receive them are clean, dry and ready for locker installation.
- B. Protect lockers from damage during delivery, handling, storage, and installation.
- C. Deliver master keys, control keys, and combination control charts to Owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain metal lockers, locker benches, and accessories from single source from single locker manufacturer.
 - 1. Obtain locks from single lock manufacturer.
- B. Manufacturers: Provide Basis of Design or approved equal by one of the following manufacturers:
 - 1. Republic Steel.
 - 2. Hallowell.
 - 3. Interior Medart.
 - 4. Lyon Metal Products.
 - 5. Penco Products.
 - 6. List Industries.

2.2 METAL LOCKERS

- A. (LKR) Metal Lockers: Welded corridor lockers, prefinished, on continuous zee base, with sloped tops and vented doors.
 - 1. Configurations: Multi-tiered configurations as shown on Drawings.
 - a. LKR-1: double-tier, painted finish, white
 - b. LKR-2: single tier, 18"x18"x72", painted finish, white
 - 2. Basis of Design: Standard Lockers by Lyon Metal Products.
- B. Continuous Zee Base: Fabricated in manufacturer's standard thickness, but not less than 0.060-inch nominal-thickness steel sheet, height as shown on Drawings. Provide matching end caps.
- C. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS), Type B, suitable for exposed applications.
- D. Factory-Finish: Baked enamel or powder coat.
 - 1. Color: Custom color as indicated on Material Identification List (PT).
- E. Doors: One piece; fabricated from 0.075-inch nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
 - 1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches wide; welded to inner face of doors.
 - 2. Door Style: Unperforated panel.
- F. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:
 - 1. Tops, Bottoms, and Sides: 0.060-inch nominal thickness.
 - 2. Backs: 0.048-inch nominal thickness.
 - 3. Shelves: 0.060-inch nominal thickness, with double bend at front and single bend at sides and back.
- G. Frames: Channel formed; fabricated from 0.060-inch nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.
- H. Hinges: Manufacturer's standard, steel, continuous or knuckle type. Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
- I. Projecting Door Handle and Latch: Finger-lift latch control designed for use with either built-in combination locks or padlocks; positive automatic latching, chromium plated; pry and vandal resistant.
 - 1. Latch Hooks: Equip doors 48 inches and higher with three latch hooks and doors less than 48 inches high with two latch hooks; fabricated from 0.105-inch nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
 - 2. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.
- J. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch high. Provide each locker with an identification plate.
- K. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated. Provide one double-prong ceiling hook and two single-prong wall hooks for each locker.
- L. Combination Padlocks: Provided by Owner or User.
- M. Continuous Sloping Tops: Fabricated from nominal 18 ga. steel sheet, with a pitch of approximately 20 degrees. Finish into inside corners and provide vertical exposed endcaps.
- N. Boxed End Panels: Fabricated from 0.048-inch nominal-thickness steel sheet.
- O. Filler Panels: Fabricated from 0.048-inch nominal-thickness steel sheet; 2 inch filler at endwalls, and inside corners.

2.3 INSTALLATION ACCESSORIES

- A. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.
- B. Anchors: Material, type, and size required for secure anchorage to each substrate.
 - 1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls, and elsewhere as indicated, for corrosion resistance.
 - 2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.4 FABRICATION

- A. Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds flush.
- B. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
 - 1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
 - 2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.
- C. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments. Factory weld frame members of each metal locker together to form a rigid, one-piece assembly.
- D. Accessible Lockers: Fabricate as follows:
 - 1. Locate bottom shelf no lower than 15 inches above the floor.
 - 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install lockers level, plumb, and true; shim as required, using concealed shims.
 - 1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
- B. Welded Lockers: Connect groups together with standard fasteners, with no exposed fasteners on face frames.
- C. Identification Plates: Identify metal lockers with identification indicated on Drawings.
 - 1. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
 - 2. Attach plates to upper shelf of each open-front metal locker, centered, with a least two aluminum rivets.
- D. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
 - 1. Attach recess trim to recessed metal lockers with concealed clips.
 - 2. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.

- 3. Attach sloping-top units to metal lockers, with closures at exposed ends.
- E. Freestanding Locker Benches: Place benches in locations indicated on Drawings.

3.3 INSTALLED WORK

- A. Repair: Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.
- B. Adjusting: Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.
- C. Protection: Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.

END OF SECTION

SECTION 112326 COMMERCIAL WASHERS AND EXTRACTORS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Washer, dryer and accessories.
- B. Laundry Appliances
 - 1. **VOC EQ-11: Clothes washer**
 - 2. **VOC EQ-12: Clothes dryer**

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.
4. NFPA 54 - National Fuel Gas Code.
5. NFPA 70 - National Electrical Code.
6. Washer-Extractor: Listed with ETL, ISO 9001 & 14001 Quality and Environmental Impact Standards.
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,
 3. General Electric,
 4. Huebsch ,
 5. Maytag,
 6. Speed Queen ,
 7. Unimac,
 8. Whirlpool.

2.3 WASHER/EXTRACTOR

- A. Washer Basis-of-Design Product: Model EXSM680 by Wascomat Laundry Equipment.
1. Type: Freestanding, front-loading washer with programmable controls.
 - a. Stainless steel front panel and side panels.
 - b. Standard 4-compartment liquid or powder supply.
 2. Capacity:
 - a. Weight: 80 lbs
 - b. Volume: 12.4 cubic feet.
 3. Dimensions:
 - a. Height: 61 13/16 inches.
 - b. Depth: 43 1/2 inches.
 - c. Width: 42 11/16 inches.
 - d. Door Opening Diameter: 21 1/16 inches.
 4. Control System: Wascomat "Selecta20". Preprogrammed with 20 wash cycles.
 5. Electric Power:
 - a. Voltage, Frequency, Phase: 208-240 V, 60 Hz, single phase.
 - b. Full Load / Circuit Breaker: 12.0A / 15A.
 6. Water Connections and Pressure:
 - a. Inlets: 3/4 inch. Two hot, one cold.
 - b. Flow (gal/min at 45 psi): 16 gal/min.
 - c. Recommended Water Pressure: 30 - 90 psi.

2.4 DRYER/EXTRACTOR

- A. Dryer Basis-of-Design Product: Model TD75 by Wascomat Laundry Equipment.
1. Type: Freestanding, front-loading, gas heat dryer.
 - a. [Residual Moisture Control (RMC).]
 2. Capacity: 75 lbs.
 3. Dimensions:
 - a. Height: 78 9/16 inches.
 - b. Depth: 53 15/16 inches.
 - c. Width: 37 13/16 inches.
 - d. Door Opening Diameter: 31 7/8 inches.

4. Control System: Wascomat "Selecta II OPL".
5. Gas-Dryer Power: [208-240 V, 60 Hz, single phase.] [208-240 V, 60 Hz, 3 phase.]
 - a. Gas: 151200 Btu / hr.
 - b. Airflow: 647 cubic feet per minute.
 - c. Full Load / Circuit Breaker: [8.3A / 15A (single phase)] [4.8A/15A (3 phase)].
6. Gas Connection and Pressure:
 - a. Gas Connection: 3/4 NPT.
 - b. Natural Gas Pressure: 3.5 - 10 inches H₂O / mbar.
7. Exhaust Connection and Pressure:
 - a. Exhaust Duct Diameter: 8 inches.
 - b. Exhaust Pressure: Maximum of 1.30 inches H₂O / mbar.

2.5 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.
- B. Related Sections: Divisions 22, 23 & 26 specifications for equipment venting, gas and utility connections, power and controls.

1.2 COORDINATION

- A. Division 26: for power, wiring.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's specifications and technical data including performance, construction and fabrication information.
 - 1. Equipment Options and Accessories: Submit to Owner for approval prior to purchase of equipment.
- B. 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.

1.4 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.
- 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.

1.5 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.

1.6 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.

1.7 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. 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.
- C. 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.
 3. Curtain: 14 mil vinyl.
 - 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. (VOC EQ-2) Walk-in Spray Hood:
 1. Basis of Design: Open Front Booth, IB Series, by Col-Met Engineered Finishing Solutions.

2.4 METAL DUST COLLECTORS

- A. (VOC EQ-3) Metal Dust Collector:
 1. Basis of Design: No. JDC-501, Cabinet Dust Collector for Metal, 115/230V, 1HP, by Jet Tools.
- B. (VOC EQ-4) Metal Dust Collector Stand for Bench Grinder:
 1. Basis of Design: No. JDCS-505, Metal Dust Collector Stand, 115V by Jet Tools.

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:
 - 1. Basis of Design: Model 500/550 HD Welding Fume Extractor, Micro-Pleat Series 1, by Sentry Air Systems, Inc..

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:
 - 1. Basis of Design: Groen Floor Kettle, Stationary Electric Model EE, by Unified Brands.

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

SECTION 116123 THEATRICAL PLATFORMS

PART 1 General

1.1 SUMMARY

- A. The work in this section includes Theatrical Platforming (TP) systems and equipment within the following spaces and associated support areas:
 - 1. Studio Theatre
 - 2. Valade Jazz Center
- B. Section Includes
 - 1. Major Systems and Equipment: furnish and install the following major elements and associated accessories:
 - a. Staging and Seating Riser System
 - 1) Platform decks with aluminum frames
 - 2) Understructure
 - 3) Step units and railings
 - 4) Closure panels
 - 5) Masking Skirts
 - 6) Aisle Lights
 - (a) Transport carts
 - (b) Spare parts
 - 2. Work Results:
 - a. The equipment installed as part of this Section shall result in a complete and working theatrical platforming system.
 - 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. Consult and coordinate with other affected work and contractors throughout the course of the work contained herein.
 - C. 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 12 – Furnishings
 - 1) Section 127100 – Portable Seating

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 <TBD>.
- C. Alternates
 - 1. Provide separate price information for material and labor associated with the following equipment and systems:

- a. <<TBD>>
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. <<TBD>>

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. CWANA – Complete with All Necessary Accessories

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.
 - 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. 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.

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. Painting
 - b. Finishing of floors and finishes

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.
- 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 sheet number and title for each sheet in the set.
 3. Provide ¼" = 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 plans and area calculations of all elements in storage.
 7. Provide indications by arrow and boxed caption of all variations from contract drawings and specifications, except where variation is indicated as acceptable.
 8. Indicate all elements with appropriate safety factors and/or safety equipment.
 9. Indicate recommended load limits for each element in the system with loading requirements.
 10. All elements shall be engineered, approved and drawings stamped by a Professional Engineer licensed in the project jurisdiction. The engineer shall verify that the equipment supplied under this section meets or exceeds the design criteria of this specification.
 11. Provide a full Bill of Materials to be supplied, including quantities, manufacturer, manufacturer's part number, reference to applicable drawings, etc.
- J. Samples
 1. Submit sample items for approval within 14 days of Architect's written request. These items may include, but are not limited to:
 - a. Standard basic components, decking section (corner cut section), tubing, feet, locking pins and hardware.

K. Certificates

1. Provide manufacturer's certificates stating materials meet fire performance characteristics as specified herein.

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.
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.
8. 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.
9. The record documents shall be reviewed by the Architect and all modifications to the documents stemming from this review shall be made as required.
10. Above submissions are required as a condition for final approval of the work.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials:

1. Furnish a package of extra materials to match those installed and taken from the same production run, packaged with protective covering for storage and identified with appropriate labels:
 - a. 4 locator plates of each type used in system
 - b. 8 locking pins of each type in the system, with cable tethers having uncrimped fittings
 - c. 8 threaded foot assemblies
2. Furnish heavy duty storage box with hinged interlocking covers to contain all above spare parts.

1.8 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Refer to Division 01 – General Requirements.

B. Qualifications

1. All equipment and installation is to be the responsibility of a single Contractor, who shall own and operate their own manufacturing facility for the fabrication of theatrical platform 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 theatrical platform systems for no less than five years.

3. 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.
4. Contractor is responsible for proper installation, operation and safety of all component equipment.
5. Equipment must be procured as specified. Non-specified items may be procured from any nationally recognized manufacturer.
6. Special fabrication such as architectural metalworking and millwork may be done by others. Such subcontracting must be approval by the Architect at the time of bid and/or as part of the submittal process. Responsibility in all respects shall be that of the Contractor.
7. The Contractor shall verify all system design loads.
8. 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 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 Platform 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. 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. 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.

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 contractors:

Staging Concepts
8400 Wyoming Avenue North, Suite 100
Minneapolis, MN 55445
Tel: (800) 337-5339

Staging Dimensions, Inc.
31 Blevins Drive Suite A
New Castle, DE 19720
Tel: (866) 591-3471

StageRight Corporation
495 Pioneer Parkway
Clare, MI 48617
Tel: (800) 438-4499

Wenger Corporation
555 Park Drive
Owatonna, MN 55060
Tel: (507) 455-4100

- 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.

2.2 SYSTEMS DESCRIPTION

- A. All components in the system shall be portable and shall be designed to minimize setup, take down, and transition time.
- B. The platforms are intended for interior use only.
- C. Studio Theatre
 - 1. Staging and Seating Riser System:
 - a. Modular platform system for use as staging and/or seating risers in multiple configurations, including the layouts shown in the project drawings. The platform system will consist of portable interlocking decks, interchangeable support structure, and accessories.
 - b. The platform heights can be varied by means of interchangeable sets of legs.
 - c. Each platform shall be provided with discrete understructure. Bridging understructure is not acceptable.
 - d. Understructures shall have Acme-thread feet allowing +/- 3" of leveling adjustment.
 - e. Accessories including guard rails, hand rails, closure panels, step units, masking skirts, and aisle lights to accommodate the configurations indicated in the drawings.
 - f. Transport carts for storage of platform system components and accessories.
- D. Valade Jazz Center
 - 1. Staging and Seating Riser System:
 - a. Modular platform system for use as staging and/or seating risers in multiple configurations, including the layouts shown in the project drawings. The platform system will consist of portable interlocking decks, interchangeable support structure, and accessories.
 - b. The platform heights can be varied by means of interchangeable sets of legs.
 - c. Each platform shall be provided with discrete understructure. Bridging understructure is not acceptable.
 - d. Understructures shall have Acme-thread feet allowing +/- 3" of leveling adjustment.
 - e. Accessories including guard rails, hand rails, closure panels, step units, masking skirts, and aisle lights to accommodate the configurations indicated in the drawings.
 - f. Transport carts for storage of platform system components and accessories.

2.3 DESIGN CRITERIA

- A. Platform System:
 - 1. Capacities
 - a. Uniform load-bearing capability at full height - 125 lbs./sq. ft. live load
 - b. Point load at deck surface - 1250 lbs./sq. inch.
 - c. Lateral load-bearing capability - 5% sway load.
 - 2. Platforms, regardless of height, will have no lateral movement.
 - a. For height configurations that require cross-bracing for added stability, the Contractor shall provide an adequate modular bracing device that will satisfy the demands of the live load requirements herein. The cross-bracing members shall not conflict with the legs of adjacent platforms and shall be in keeping with the construction methods described herein.
 - 3. Platforms shall be interlocking side-to-side and front-to-back by means of a connection device that cannot be compromised by the rigors of performer movement or audience loading. Positive interlock shall be assured between adjacent platforms whether they are at equal or dissimilar heights.
 - 4. The support system shall be fabricated in such a manner that the platform may be disassembled for repairs. The Contractor shall be obliged to make all parts available to the purchaser. Mechanically connected construction which cannot be repaired on site is not acceptable.
 - 5. No component requiring manual lifting shall weigh more than 150 lbs.

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 labels.
3. Structural metal elements to be steel, extruded aluminum, or equal.
4. All corners, joints, etc. to be die-cast aluminum, or equal.

B. 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.
4. Elements to be fastened with removable fasteners, no welds, so that components may be easily repaired. Platform decks excepted.

C. Finishes

1. Exposed surfaces to be finished flat black.
2. Fabric:
 - a. Materials shall be either IFR polyester to conform to local, state, and national codes. Affidavits from fabric manufacturer, jobber or other agent required to attest flame resistance of the fabrics and methods used shall accompany drapery upon delivery.

2.5 EQUIPMENT AND COMPONENTS

A. Platform Decks

1. Provide portable, structural platforms consisting of a plywood and hardboard finish on an extruded aluminum frame.
2. Platform decks shall be single-sided:
 - a. Finish layer to be painted double tempered hardboard or tempered plyon.
 - 1) Paint shall be Rosco Tough Prime, flat black
 - b. There shall be no irregularities or protrusions beyond the surface plane, which shall be completely flat. Holes or permeations shall not exceed ¼" in any dimension. Surface shall be non-reflective and able to withstand mopping.
3. Frame shall be constructed of extruded structural aluminum and finished with baked-on matte black epoxy paint. The extrusion shall be a box design for maximum strength and rigidity, with lip to protect the top surface edge and grooves to interconnect platforms and additional accessories. The overall thickness of the frame shall not be greater than 4".
4. Deck units shall be provided with sockets to accept detachable legs.
5. Provide acoustic dampening at undersides of platforms.
6. The total weight of each platform deck shall not exceed 150 lbs.
7. Provide in quantities required for configurations of the system as shown on drawings (not simultaneously).
8. Provide:
 - a. Staging Concepts SC90 Deck
 - b. Or Approved Equal

B. Understructure

1. Provide independent understructure to support individual platform decks as described above.
2. Legs shall positively lock into place at sockets permanently mounted on the underside of the platform decks.
3. Legs shall be fabricated from structural aluminum tubes in lengths to provide installed platform heights as indicated on the drawings.
 - a. Variable height legs, where required, shall be adjustable in increments as indicated on drawings.
4. Legs shall be joined and stabilized, when required, by cross bracing comprised of aluminum tubing and formed steel brackets. Installation of the bracing components shall not require the use of special tools.

5. Legs shall have Acme-threaded leveling feet which provide an additional 3" of height adjustment.
 6. All components of the understructure shall be finished with baked-on matte black epoxy paint.
 7. Provide in quantities and lengths required for configurations of the system as shown on drawings (not simultaneously).
- C. Guard Rails
1. Provide guard rails and hand rails as shown on the drawings.
 2. Provide positive attachment to platform and/or step unit edge via hand-operated clamps.
 3. All components shall be finished with baked-on matte black epoxy paint.
 4. Provide with all necessary hardware and attachments.
 5. Provide guard rails in quantities required for configurations of the system as shown on drawings (not simultaneously).
- D. Step Units
1. Provide step units as shown on the drawings.
 2. Step units shall meet same loading criteria as platform system.
 3. Box construction with finish fascia on all exposed sides.
 - a. Finish surface shall be of the same material as platform decks, finished flat black.
 - b. Support fascia at perimeter and center of each step.
 4. Provide positive attachment between step units and platform decks.
 5. Provide with all necessary hardware and attachments.
 6. Provide in quantities required for configurations of the system as shown on drawings (not simultaneously).
- E. Closure Panels
1. Provide continuous closure panels to fill in vertical openings at platform faces, and between platform levels when used at alternate heights.
 2. Panels shall prevent chair legs from slipping off the platform decks as well as prevent sightlines through the platforms to the understructure.
 3. Panels shall have positive attachment to platform frame.
 4. Exposed finish side shall be of the same material as platform decks, finished flat black.
 5. Provide in quantities required for configurations of the system as shown on drawings (not simultaneously).
- F. Masking Skirts
1. Provide fabric skirting to mask sides and back of understructure of seating riser system.
 2. Panels shall be no longer than 2x the long dimension of a deck. Attach to deck perimeter with heavy-duty hook and loop fasteners or tight fitting clips.
 3. Fabric shall be inherently flame retardant and shall be a polyester-based woven product.
 4. Masking panels shall be constructed without fullness and hemmed on all edges.
 5. Color shall be black.
- G. Aisle Lights
1. Provide UL approved low voltage warm white LED aisle lighting fixtures for installation centered in face of intermediate aisle risers.
 2. Provide nose mounted low voltage fixture. Provide required transformers to be mounted within the platform system.
 - a. Aisle lighting shall comply with all local codes with respect to egress path lighting of 0.2 footcandles, continuous along the entire egress path, or as required for public assembly seating at the time of contract.
 3. Step lights shall be provided on intermediate steps and at aisle closure panels.
- H. Transport Carts
1. Provide a sufficient quantity of transport carts to allow for the complete storage of all system components. This shall include, but is not limited to:
 - a. Platform decks
 - b. Support structure
 - c. Railings

- d. Closure panels
 - e. Step Units
 - f. Accessories and tools
2. Provide carts of welded steel construction, finished flat black.
 3. Provide stackable carts with fork lift sleeves.
 4. Provide carts in Manufacturer's standard sizes.
 5. Carts must be able to fit through standard doorways to access storage areas.
 6. Provide heavy duty 6", 900lb. capacity casters. Casters must operate smoothly over hard, carpeted, or paved surfaces.

2.6 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.
- 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).

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. 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. Coordinate work with all other trades to avoid causing delays in construction schedule.
- E. All field welding requires prior approval of the Architect and Contractor's Structural Engineer.
- F. 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).
- G. 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.

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. 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 Contract Drawings prior to the demonstration indicated herein.

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 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 to be operated for approval and inspected for quality by the Theatre Consultant, the Architect and the Owner.
 3. Platforms shall be set up in a specified configuration for review.
 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 an instruction session to the Owner's staff or representatives on the safe operation, care and maintenance of the system.
 - 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 adequate training time for all configurations to be assembled, disassembled and returned to storage.
 2. Schedule the instruction session in conformance with the project construction schedule and the availability of the Owner.
 3. Instruction will be by technical staff of the Contractor.

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 components thoroughly prior to the demonstration session.

END OF SECTION

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. Studio 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
 - 1) Locking rail
 - 2) Belaying pins
 - 3) Index Lights
 - b. Proscenium safety curtain with lineshaft winch
 - c. Stage Traveler Track assemblies
 - d. Rope rigging for multi-cable management
 - e. Zero fleet hoist
 - f. Zero fleet hoist with integrated structural backbone
 - g. Rigging Control System
 - h. Pipe Grid
 - i. Walk-Draw Drapery Track
 - j. Miscellaneous rigging equipment and accessories
 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. Operating gallery 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 116113 – Orchestra Shell Enclosure
 - 2) Section 116143 – Theatrical Drapery
 - 3) Section 116163 – Theatrical Lighting Dimming and Control
 - 4) Section 116183 – Theatrical Audio Video Systems
 - 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 for material and labor associated with the following equipment and systems:
 - a. <<TBD>>

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. Paint Shop – 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. MCC – Motor Control Center
 - b. ACC – Automation Control Console
 - 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.
 - 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.
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
 - 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
 - 3) UL 467 (2004) Standard for Grounding and Bonding Equipment
 - 4) UL 50 (2003; R 2005) Standard for Enclosures for Electrical Equipment
 - 5) UL 969 (1995; rev Thru Dec 2006) Marking and Labeling Systems

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 ¼" = 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.
- L. Samples
1. Submit sample items including, but not limited to:
 - a. Samples of pipe grid hanging hardware and connections, pipe grid junction hardware.
 - b. Samples of drapery tracks and associated hardware.
 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.
- 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 1.1 x SWL (drop test)
 - 4) Dynamic test of secondary brake to 1.1 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. 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 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 2 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.

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 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 impermeate 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. Automatic Devices Company (ADC)
- b. H & H Specialties Inc.
- c. J.R. Clancy, Inc.
- 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
- 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.
 - 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. Fixed Speaker rigging
 - 1) Provide and install the rigging components necessary to rig the **overhead** speaker clusters
 - e. Portable Capstan Winch
 - f. Stage Traveler Track assemblies
 - 1) Main Drape traveler track shall be furnished for manual, bi-parting, back-packing curtains.
 - 2) Side Tab traveler tracks shall be furnished for manual back-packing curtains.
 - g. Rigging Control System
 - 1) Provide a control system for the motorized theatrical rigging equipment as indicated on the drawings and as detailed herein.

- 2) Additional control system components:
 - (a) Motor control cabinets (MCC)
 - (b) Motion Control Racks (MCR)
 - (c) Control points and E-Stop
 - (d) Hand held control pendant
 - (e) Control pendant receptacles
 - (f) Control for all motors herein
 - h. Acoustic Drapery Track
 - 1) Walk-draw track assembly
 - 2. Studio Theatre
 - a. Tension Wire Grid
 - b. Demountable dead hung drapery pipe battens
 - 3. Valade Jazz Center
 - a. Zero Fleet Motorized Batten System
 - b. Rigging Control System
 - c. Fixed Speaker rigging
 - 1) Provide and install the rigging components necessary to rig the **overhead** speaker clusters
 - d. Acoustic Traveler Track assemblies
 - 1) Acoustic backdrop drape traveler track shall be furnished for manual, bi-parting, back-packing curtains.
 - 4. Paint Shop
 - a. Zero Fleet Motorized Batten System with Integrated Structural Backbone
 - b. Rigging Control System
 - c. Pipe Grid
- 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 track.
2. Provide new 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. Bumper strips at electric battens to limit high trim coincident with cable pick-up maximum travel.

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 1/2" 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%
2. Provide counterweight for the following:
 - a. Pipe weight for general purpose linesets
 - b. Pipe weight for fixed electric battens
 - c. Main Drape and Valance
 - d. 60% of total system working load limit capacity
 - 1) Approximately 52,000 lbs.
3. All weights to be painted with shop coat of flat grey alkyd primer, Benjamin Moore Corotech Alkyd Shop Coat Primer or equal.
 - a. All pipe weight to be completely painted bright yellow.
4. After painting the counterweight shall be distributed:
 - a. 90% at the loading gallery
 - b. 10% at the stage floor
5. Provide necessary thinner sheet steel weights for fine trimming of Main Drape.
6. 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 sleeves 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 sleeves 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 couplings, 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 segments and couplings to be secured with 5/16" bolts, lock washers and nuts.
 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
1. Unspliced ¾" first grade line of filament and staple/spun polyester wrapped fibrillated polyolefin. Three-Strand Composite Multiline II, color standard white as manufactured by New England Rope or equal. Clean of slivers and foreign materials.
 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
1. Steel, quick-acting eccentric levers. Heat treated steel cams.
 2. Cast iron bodies acceptable (#30 gray iron).
 3. Provide 3/8" lock adjustment set screw.
 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 ¾" 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 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 Timkin 7204-B cup and 07100 preloaded cone roller, (no known 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 2" x ¼" clips with forged offset or space plate for thickness of beam flange. Clips bolted to block by 2 ½" 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. 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 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 with pivot bracket with a pair of 1½" x 1½" x ¼" angles that bolt to loft block base angles and a pair of 1½" x 1½" x ¼" angles attached to roof beams with double 2" X 1¼" clips with forge offset or spacer plate for thickness of beam flange. A ¾" diameter threaded rod to connect the two sets of angles and provides the pivot point. Clips bolted to angle by 2 - 7/16" bolts at each side.

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. 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. Working Load Limit and total load capacity of fixed electric sets
 - d. 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.

P. Wooden Belaying Pins

1. Pins shall be 21" long by 1-5/32" in diameter with a shoulder and handgrip at the top.
2. Belaying pins shall be machine turned from hardwood and shall fit 1-1/4" diameter holes in the pin rail.
3. Provide 10

2.5 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. Traveler tracks for side masking draperies to be single sections, fitted for manual line operation.
4. 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.
5. 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

2.6 SPEAKER RIGGING

- A. Confirm speaker loading configuration with the structural engineer of record.
- B. Provide all necessary rigging components to safely rig the speaker cluster. The safety factor of the components shall be 10:1. This includes but is not limited to; beam clamps, turnbuckles, wire rope, thimbles, compression sleeves, etc.

2.7 MOTORIZED ZERO-FLEET HOIST BATTENS WITH INTEGRATED STRUCTURAL BACKBONE

- A. Winch Architecture
 1. Zero Fleet:
 - a. Provide a system of compact horizontally or 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 to 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 immoveable 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 $\pm 6\%$. 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. Adjustable acceleration and deceleration:
 - a. The acceleration and or deceleration of the hoist shall be user configurable from the control console, and shall be capable of straight line or S shape acceleration/deceleration ramp curves up to the maximum rates listed above.
- 13. Power and Control Wiring

- a. Power and control cables shall be provided with each winch.
 - b. Power cables shall be properly rated SO cable with NEMA locking connectors. Control cables shall have connectors with steel body and position locking.
 - c. Power and control wireways shall be provided with receptacles to mate with connectors on provided power and control cables.
14. The hoist shall be (no other known equals):
- a. The PowerLift series by J.R. Clancy
 - b. Prodigy P1900G Hoist by ETC Rigging
- B. Integrated Structural Backbone and Beam Clamps
1. The Structural Backbone shall be a continuous channel of extruded aluminum engineered so as not to add horizontal forces on the building when used in combination with the slip fit beam clamps.
 - a. The tube shall support the loft blocks mounted within the spacing limits of the system.
 - b. Structural Backbone sections shall be joined into a continuous assembly by a pair of dedicated splicing plates at each Structural Backbone joint.
 - c. The Structural Backbone shall be installed only by means of dedicated beam clamps that allow the Structural Backbone to snap-into place and move horizontally to neutralize additional lateral forces on the structure.
 - d. Beam clamps shall be capable of attaching to horizontal beams, joist flanges or flat steel plates measuring from .25" thick up to 1" thick and from 4.25" wide up to 14" wide.
 - e. Hoist systems that add lateral forces to the building shall not be accepted for this project.
 - f. The Structural Backbone shall permit positioning of loft blocks anywhere along its length.
 2. Loft Blocks:
 - a. Each loft block shall be an assembly of steel side plates, a wire rope idler, sheave support hardware and an assembly to prevent the loft block from sliding horizontally. Each loft block shall be inserted into a slot on the bottom of the Structural Backbone.
 - b. Loft blocks sheaves shall measure 5.25" in diameter and contain a pair of press fit sealed ball bearings.
 - c. Lift lines shall travel in a groove shaped and sized for 3/16" diameter wire rope per the latest edition of the Wire Rope Users' Manual as published by the Wire Rope Technical Board. The loft block sheave shall be concentric about the hub and shall be evenly balanced for ease of rotation.
 - d. An idler shall be incorporated into the top assembly of the loft block to guide and support lift lines as they pass the loft block.
 - e. Hoisting systems requiring the loft blocks to be mounted directly to the facility steel shall not be accepted for this project.
- C. Lift Lines:
1. Oil-free, zinc coated, 3/16" or 1/4", 7x19 aircraft cable. 7,000 lbs. minimum breaking strength for 1/4" or 4,200 lbs minimum breaking strength for 3/16".
 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.
- D. Pipe Battens:
1. Provide segmented battens complete with couplings, connectors and fittings as indicated on the Drawings. Pipe to be of 1 1/2" nominal Schedule 40 black steel pipe as per standard industry practice.
 2. Batten segments and couplings to be secured with 5/16" bolts, lock washers and nuts.
 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.

2.8 RIGGING CONTROL SYSTEM (RCS)

- A. Provide a control system for the motorized theatrical rigging equipment as indicated on the drawings and as detailed herein.
 1. Controller shall be (provide 1):
 - a. JR Clancy: Scene Control Pendant
 - b. ETC Rigging: QuickTouch 1-channel
 - c. Or approved equal
 2. Additional Control System components:
 - a. Motor control cabinets (MCC)
 - b. Motion Control Racks (MCR)
 - c. Control point and E-Stop
 - d. Control pendant receptacles
 - e. Control for all motors herein

2.9 MOTORIZED ZERO-FLEET HOIST BATTENS

- A. Winch Architecture
 1. Zero Fleet:
 - a. Provide a system of compact horizontally or 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 to 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 capable 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 $\pm 6\%$. 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. Adjustable acceleration and deceleration:
- a. The acceleration and or deceleration of the hoist shall be user configurable from the control console, and shall be capable of straight line or S shape acceleration/deceleration ramp curves up to the maximum rates listed above.
13. Power and Control Wiring
- a. Power and control cables shall be provided with each winch.
 - b. Power cables shall be properly rated SO cable with NEMA locking connectors. Control cables shall have connectors with steel body and position locking.
 - c. Power and control wireways shall be provided with receptacles to mate with connectors on provided power and control cables.
14. The hoist shall be (no other known equals):
- a. The PowerLift series by J.R. Clancy
 - b. Prodigy P1900G Hoist by ETC Rigging

B. Lift Lines:

1. Oil-free, zinc coated, 3/16" or 1/4", 7x19 aircraft cable. 7,000 lbs. minimum breaking strength for 1/4" or 4,200 lbs minimum breaking strength for 3/16".
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 couplings, connectors and fittings as indicated on the Drawings. Pipe to be of 1 1/2" nominal Schedule 40 black steel pipe as per standard industry practice.
2. Batten segments and couplings to be secured with 5/16" bolts, lock washers and nuts.
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 1/4" 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 15mm 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 1 1/2" x 1 1/2" x 1/4", 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 system cable. Precision ball bearings. Provide spacers as required to locate sheaves 1/2" on center, sheave to sheave. Each loft block shall have one idler for each cable which passes it.
8. Idler sheave as shown on drawings.
9. Loft blocks attached to roof beams by double 2" X 1 1/4" clips with forge offset or spacer plate for thickness of beam flange. Clips bolted to block by 2 7/16" bolts at each side.

2.10 RIGGING CONTROL SYSTEM (RCS)

- A. Provide a control system for the motorized theatrical rigging equipment as indicated on the drawings and as detailed herein.
1. Controller shall be (provide 1):
 - a. JR Clancy: Scene Control 12
 - b. ETC Rigging: QuickTouch 4-channel
 - c. Or approved equal
 2. Additional Control System components:
 - a. Motor control cabinets (MCC)
 - b. Motion Control Racks (MCR)
 - c. Control point and E-Stop
 - d. Control pendant receptacles
 - e. Control for all motors herein

2.11 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.
2. Compression sleeves and tools shall be the product of:
 - a. National Telephone Supply Company, Locoloc, or equal.

F. 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.

G. 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.

H. 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.

2.12 PIPE GRIDS

- A. Provide pipe grids as shown on the contract drawings. Pipe battens of 1½" nominal diameter I.D. (1.9" outside diameter) Schedule 40 black steel pipe as per standard industry practice.
- B. Provide dead-hung pipe grids as shown on the Drawings.
- C. All hardware to be finished with flat black matte epoxy paint.
- D. Pipe splices to be 18" close fitted internal sleeves secured by 2 bolts perpendicular to floor on each side of joint. ¼" x 20 cap screws through-bolted with nylock nuts. Holes 6" on center, 3" from ends.

- E. Provide rigid supports to overhead structure as shown in drawings and as required to meet specified loading criteria as well as local seismic codes. Confirm final support design with structural engineer.
- F. Provide lateral support to building structure as shown in drawings and as required to meet specified load criteria.
 - 1. Grid wall flange SSRC #WF or equal
- G. Load criteria
 - 1. 30 lbs/lin. ft. uniform load.
 - 2. 100 lb maximum point loads at center of spans.
 - 3. Maximum working load over pipe grids:
 - a. Paint Shop: 3 tons
- H. Pipe grid hangers:
 - 1. WT 3x8 Steel T batten clamp as shown in the drawings
 - 2. Rated hot dip galvanized jaw/ open thread turnbuckle with 6" of take-up, locking hardware and safety wire mouse (after adjustment).
 - 3. Threaded rod sized as appropriate for load / safety factor.
 - 4. Pipe clamp: ADC#2815, or equal
- I. Pipe grid junction connections:
 - 1. Provide J.R. Clancy or SSRC full cross grid connector,
 - 2. Pipe grid junction connections shall be located at a minimum of 50% of all grid junctions.

2.13 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.
 - g. Hanger fitting and clamps for attachment spaced at 5'-0" on center maximum or as recommended by manufacturer.
 - 3. Carriers:
 - a. Provide two master carriers per drapery panel. Each with 4 paired neoprene wheels with ball bearings.
 - b. Single carriers to have two neoprene wheels with ball bearings.
 - c. Each single carrier to have single plated swivels with 6" of usable trim chain.
 - d. One single carrier for each 1'-0" of track length.
 - e. Neoprene bumpers and nylon strips attach to carrier to assure quiet operation.
 - f. Finish Black.
 - g. Walk-draw track shall include a paging cord at both ends of curtain attached to master carriers.
 - 4. Acceptable Products:
 - a. ADC Patriarc 500 series
 - b. H&H 500 series
 - c. Or approved equal

2.14 REMOVABLE DEAD HUNG DRAPERY BATTENS

- A. Furnish and install dead hung pipe battens for support of masking drapery and tracks.

2.15 MISCELLANEOUS RIGGING EQUIPMENT AND ACCESSORIES

- A. Provide loose rigging equipment and accessories as indicated in the Appendix.
<<Appendix not provided as part of Design Development Submission>>

2.16 SOURCE QUALITY CONTROL

- A. All equipment and components to be factory tested prior to shipping.

2.17 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).

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

J.R. Clancy Incorporated
7041 Interstate Island Road
Syracuse, NY 13209-9713
Tel: (800) 836-1885

LVH Entertainment Systems
1801 Highland Avenue,
Unit E
Duarte, CA 91010
Tel: (805) 278-4584

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.
- 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. 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.

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 ask for the CTP to be repeated on randomly selected hoist units during the equipment Demonstration. Failure to reproduce the tests on two of the units will require complete retesting of all units in the presence of the Theatre Consultant.

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.

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.
- B. <<Appendix not provided as part of Design Development Submission>>

END OF SECTION

SECTION 116135
STAGE EXTENSION – ORCHESTRA PIT LIFT SYSTEM

PART 1 GENERAL

1.1 SUMMARY

- A. The work in this section includes Theatrical Stage Extension - Orchestra Pit Lift systems and equipment within the following spaces and associated support areas:
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) Floor boxes
 - 2) Cable Management
 - 3) Rigid telescoping skirt with safety net
 - b. Stage Lift Controls
 - c. Safety Devices
 - 1) Removable safety railings
 - 2) Astragal safety tape switches
 - 3) Access hatch and removable railing interlocks
 - 4) Door interlocks
 - d. 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 Control Centers
 - c. Multi-cable for orchestra pit lift aisle light floor boxes
 - d. 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, stage edge skirt proximity sensors, 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) Partial height wall with removable sections at audience side of the lift (see Architectural Documents).
 - f. Division 11 – Equipment
 - 1) Section 116133 – Theatrical Rigging
 - 2) Section 116137 – Adjustable Acoustic Banners
 - 3) Section 116163 – Theatrical Lighting Dimming and Control
 - 4) Section 116183 – Theatrical Audio Video Systems
 - g. Division 12 – Furnishings
 - 1) Section 126100 – Fixed 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.
- C. Alternates
 1. Provide separate price information for material and labor associated with the following equipment and systems:

- a. <<TBD>>
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. <<TBD>>

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.
 - 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 E1.42 – 2016 Entertainment Technology – Design, Installation, and Use of Orchestra Pit Lifts
 - 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
- 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
 - 3) UL 467 (2004) Standard for Grounding and Bonding Equipment
 - 4) UL 50 (2003; R 2005) Standard for Enclosures for Electrical Equipment
 - 5) UL 969 (1995; rev Thru Dec 2006) Marking and Labeling Systems

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.
- 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 1/4" = 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. Limit switches
 - d. Rigid Chain
 - e. Lift guide rail and block
 - f. Interlock switches/sensors
 - g. Digital optical encoders
 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: (866) 647-5046

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 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. The finished lift shall be equipped to receive power and control receptacles as indicated on the drawings. Coordinate this work with the Electrical Contractor and/or AV Contractor.
 - c. Cable management shall be provided for any flexible cabling between the machine pit and the stage lift floor.
 - d. The underside of the lift shall have a rigid telescoping skirt with safety net to prevent access to the machine pit from the orchestra pit / trap room.
 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).
 3. Safety Devices
 - a. The orchestra pit lift shall be provided with removable, socketed safety railings as shown in the drawings. Coordinate railing fabrication with details in Architectural drawings.
 - 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 STAGE LIFT

A. Operating Criteria

1. Electro-mechanical Lifting Mechanism (Option 1):
 - a. Spiralift by Gala
2. Electro-mechanical Lifting Mechanism (Option 2):
 - a. Linklift rigid push chain columns by Serapid
3. Travel Speed: as per drawings
4. Sustaining Capacity: as per drawings
5. Lifting Capacity: as per drawings
6. "Point Load" Capacity: 1000 lbs. castored wheel load
7. Vertical Drift: 0 under full load
8. Programmed Stops:
 - a. Stage Level
 - b. Audience Level
 - c. Orchestra Pit Level
 - d. Basement Level
9. Total Travel
 - a. 12'-0"
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: 480VAC, 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. 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. 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. Rigid Chain Columns
 - a. Provide rigid push chain lifting columns as indicated in the Drawings.

- b. Drive mechanism shall be inherently self-locking regardless of the elevation or load imposed.
 - c. Provide rigid chain storage magazine cover.
 - d. Front of chain attachment with reaction plate bolted to the lift superstructure.
 - e. 90 degree reaction base plate with mounting angles for attachment to the machine room floor.
 - f. The columns shall have flexible dust / debris cover at the top chain input port.
 - g. Linklift Chain gearbox
 - 1) The chain shall be driven by a planetary gear box that is sized to resist the loads with appropriate safety factors as described herein.
 - h. Provide Linklift columns by Serapid, sized as required to meet operating criteria as indicated above and in drawings.
3. Spiralift Columns
- a. Provide Spiralift columns as indicated in the Drawings.
 - b. Top of Spiralift attachment with reaction plate bolted to the lift superstructure.
 - c. 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.
 - d. Provide base plate with mounting angles for attachment to the machine room floor.
 - e. Spiralift worm gear:
 - 1) The column shall be driven by a worm gear that is engineered to resist the loads with the appropriate safety factors as described herein.
 - f. Provide Spiralift columns by Gala Systems, sized as required to meet operating criteria as indicated above and in drawings.
4. 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.
5. 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 an integral part of the motor and shall operate on single-phase AC. 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.

D. 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.

E. Positioning

- 1. Position feedback will be by absolute encoder.

F. Limit Switches

- 1. Provide lever operated hatchway type limit switches for top and bottom extreme travel and intermediate stops. Mount limit switches at guide chase.
- 2. Secondary or final backup limit control shall be by the lever operated limit switches.

G. Floor boxes

- 1. Provide flush-mounted floor boxes for aisle light power receptacles with covered faceplates. Faceplates to match those for aisle lights at fixed audience seating. Receptacles and faceplates to be provided by Division 26.
- 2. Coordinate floor box type and locations with Electrical Contractor to ensure that lift platform framing does not conflict with receptacle locations.

H. Cable Management

- 1. Provide cable management system and associated flexible cable for the stage lifts. The demarcation will be the junction boxes mounted by the Electrical Contractor on the floor of the machine pit. The Contractor must provide all cable management between the junction boxes on pit slab and on the stage lift.

I. Telescoping Skirt

- 1. Provide a rigid telescoping skirt with safety net as indicated in the drawings.

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. Labels to be engraved and white filled.
 - b. Prewire the panel at the factory, insofar as possible.
 - c. Terminate field connections on a clearly labeled terminal strip.
 - d. Panel to contain the following controls:
 - 1) One 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. 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 Controls:
 - 1. Provide motor drives by:
 - a. Siemens
 - b. Mitsubishi
 - c. Or approved equal
 - 2. Logic systems to be solid state. Use of relays requires prior approval.
 - 3. Provide lift control/starter cabinet and logic panel attached to wall as indicated in the drawings.
- G. Provide junction/pull boxes as shown on control riser and ensure that conduit penetrations conform to acoustical penetration guidelines under Division 26.

2.6 SAFETY DEVICES

- A. Safety Railings
 - 1. Provide removable, socketed safety railings as indicated in the drawings.
- B. 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. The decorative orchestra pit railing interlocks shall restrict the lift from traveling below audience elevation unless the rail interlocks are detected. Provide a reliable sensing system with handrail 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 de-activate restricted travel for the lift.
 - 1) The decorative orchestra pit railing is provided by others. Coordinate circuit wiring with railing manufacturer, electrical engineer, and architect.
 - b. The chair storage room railing interlocks shall restrict the lift from traveling above Basement level unless the rail interlocks are detected. Provide a reliable sensing system with handrail 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 de-activate restricted travel for the lift.
 - 1) The chair storage room railing is provided by others. Coordinate circuit wiring with railing manufacturer, electrical engineer, and architect.
 - 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.
 - c. Access Hatch
 - 1) The Machine Pit access hatch shall be locked when lift is in motion.
- C. 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 and then automatically reverse direction for 6" of travel.
- D. Motor controls will be sized to disengage or shunt at a value no greater than the capacity of the motor.
- E. A visual flashing and audible "beeping" indicator will be activated in the pit area whenever the lift is in motion.
- F. 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

SECTION 116143 THEATRICAL DRAPERY

PART 1 GENERAL

1.1 SUMMARY

- A. The work in this section includes Theatrical Draperies (TD) and equipment within the following spaces and associated support areas:
 - 1. Proscenium Theatre
 - 2. Studio Theatre
 - 3. Valade Jazz Center
- B. Section Includes
 - 1. Major Systems and Equipment: furnish and install the following major elements and associated accessories:
 - a. Main Drape and Valance
 - b. Stage masking draperies: borders, legs and side tabs
 - c. Scrim
 - d. Cycloramas
 - e. Under gallery masking draperies
 - f. Walk-draw acoustic draperies
 - g. Electrics heat resisting borders
 - h. Bottom pipes
 - i. Drapery storage bags/hampers
 - j. Fabric remnants from the manufacture of the theatrical draperies
 - 2. Provide all materials, components and services required to provide the work as specified herein, elsewhere in the project documents, and/or as shown on related drawings.
 - 3. Consult and coordinate with other affected work and contractors throughout the course of the work contained herein.
- C. 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 116113 – Orchestra Shell Enclosure
 - 2) Section 116133 – Theatrical Rigging
 - 3) Section 116163 – Theatrical Lighting Dimming and Control
 - 4) Section 116183 – Theatrical Audio Video Systems
 - g. Division 21 – Fire Suppression
 - h. Division 22 – Plumbing
 - i. Division 23 – Heating, Ventilating and Air Conditioning

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 <TBD>.

C. Alternates

1. Provide separate price information for material and labor associated with the following equipment and systems:
 - a. <<TBD>>
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. <<TBD>>

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. NFPA: National Fire Protection 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 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 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. 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.

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 begin following the completion of work which may be in conflict with the installation, including:
 - a. Theatrical rigging battens
 - b. Miscellaneous metals, specialty hanging pipes
 - c. Theatrical drapery traveler tracks
 - d. Painting
 - e. Finishing of 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 re-submittals 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. 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. 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.
- H. Shop Drawings
 - 1. Include a cover sheet with a drawing index including the sheet number and title for each sheet in the set.
 - 2. Provide 1/4" = 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 contract.
 - 3. Provide indications by arrow and boxed caption of all variations from contract drawings and specifications, except where variation is indicated as acceptable.
 - 4. Provide a full Bill of Materials to be supplied, including quantities, manufacturer, manufacturer's part numbers, etc. Provide an inventory of all draperies to be supplied, indicating fabric type, fullness, edge finish, color and size.
- I. Samples
 - 1. Submit sample items for approval within 14 days of Architect's written request. These items may include, but are not limited to:
 - a. 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.
 - b. Samples of standard hooks, swivels, ties and hardware.
 - c. Samples of drapery tracks and associated hardware.
- J. Certificates
 - 1. Provide manufacturer's certificates stating materials meet fire performance characteristics as specified herein.

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” inventories of all draperies. These inventories shall include information as to the method used to flameproof each item.
 - 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.
 - 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.
 - 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 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 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. Manufacturers
 - a. The Manufacturer shall own and operate their own manufacturing facility for the fabrication of stage curtains and draperies, 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.
 - b. The Manufacturer shall have been continuously engaged in the fabrication of theatrical draperies for no less than five years.
 - 2. Installers
 - 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 equipment specified herein and meets the following requirements.
 - b. The Contractor shall have been in the theatrical drapery and installation business continuously 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.

- c. 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.
- d. 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.
- e. Contractor is responsible for proper installation, operation and safety of all component equipment.
- f. 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.
- g. 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.
 - 4. All required weights and bottom pipe to be shipped separately from draperies and installed on the job site.
 - 5. 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 draperies and 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 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 General Contractor. All additions and/or corrections are to be requested prior to fabrication.
- B. Field Measurements:
 - 1. Field measurements shall be taken prior to preparation of shop drawings 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 30 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 installation services provided under this Section for a period of two (2) years following the date of final acceptance. Ordinary wear and defects due to improper usage are excepted.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. To establish comparative standards of quality, the Contractor may install drapery as manufactured by the following:

Gerriets International, Inc.
130 Winterwood Avenue
Ewing, NJ 08638
Tel: (609) 771-8111

iWeiss
815 Fairview Avenue, #10
Fairview, NJ 07022
Tel: (888) 325-7192

Pook Diemont & Ohl / Texas Scenic
701 East 132nd Street
Bronx, NY 10454
Tel: (718) 402-2677

Rose Brand
4 Emerson Lane
Secaucus, NJ 07094
Tel: (800) 223-1624

Stage Decoration and Supplies
3519 Associate Drive
Greensboro, NC 27405
Tel: (336) 621-5454

- B. 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 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).

2.2 SYSTEMS DESCRIPTION

A. The following performance spaces shall contain the following major system components listed below and as shown on the TD-series drawings:

1. Proscenium Theatre
 - a. Main Drape and Valance
 - 1) Decorative lined velour curtains located at the proscenium
 - b. Stage Masking Draperies
 - 1) Legs: velour curtains hung from system pipe battens
 - 2) Borders: velour curtains hung from system pipe battens
 - 3) Side tabs: velour curtains hung from traveler track at stage sides
 - c. Scrim
 - 1) Seamless black sharkstooth scrim hung from system pipe battens
 - 2) Seamless white sharkstooth scrim hung from system pipe battens
 - d. Cyclorama
 - 1) White leno-cloth cyclorama hung from system pipe batten
 - 2) Translucency: White Rear Projection Screen hung from system pipe batten
 - 3) Bounce: Seamless bleached white muslin cyclorama hung from system pipe batten
 - e. Under Gallery Masking Draperies
 - 1) Velour curtains hung from fixed pipes mounted under galleries
 - f. Walk Draw Acoustic Draperies
 - 1) Velour curtains hung from traveler track mounted to the orchestra pit wall
 - g. Electrics heat resisting borders
 - h. Bottom Pipe
 - i. Heavy-duty canvas storage bags
2. Studio Theatre
 - a. Stage Masking Draperies
 - 1) Legs: velour curtains hung from dead hung pipe battens
 - 2) Borders: velour curtains hung from dead hung pipe battens
 - 3) Side tabs: velour curtains hung from traveler track at stage sides
 - b. Scrim
 - 1) Seamless black sharkstooth scrim hung from system pipe battens
 - 2) Seamless white sharkstooth scrim hung from system pipe battens
 - c. Cyclorama
 - 1) White leno-cloth cyclorama hung from system pipe batten
 - 2) Translucency: White Rear Projection Screen hung from system pipe batten
 - 3) Bounce: Seamless bleached white muslin cyclorama hung from system pipe batten
 - d. Under Gallery Masking Draperies
 - 1) Velour curtains hung from fixed pipes mounted under galleries
 - e. Electrics heat resisting borders
 - f. Bottom Pipe
 - g. Heavy-duty canvas storage bags
3. Valade Jazz Center
 - a. Acoustic Backdrop Draperies
 - 1) Decorative velour curtains located at the upstage wall hung from traveler track mounted from wall brackets

B. Refer to the drapery schedules and project drawings for drapery requirements and quantities.

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. In all cases, fabrics are to be "first quality". In no case shall "seconds" or re-dyed fabric be acceptable.
3. All velour fabric to be free of crush marks, nap irregularities, and any other abnormal markings.
4. All variations from the specified materials and product must be approved by the Architect and Theatre Consultant.

B. Dyeing and Flameproofing:

1. Fabrics shall be vat-dyed with no variation of color or pigment impregnation. There shall be no evidence of streaking or color variation. Verification of fabric quality is the responsibility of the fabricator prior to sewing.
2. Materials shall be either IFR polyester or through-flame retarded to conform to local, state, and national codes. Affidavits from fabric manufacturer, jobber or other agent required to attest flame resistance of the fabrics and methods used shall accompany drapery upon delivery. Duplicate copies shall be sewn to a normally accessible but hidden corner of each piece of drapery goods.
 - a. Provide a 100 square inch cutaway sample of drapery fabric and lining sewn adjacent to flame resistance certification on rear for use in Fire Marshall testing.
3. There shall be no chemical leach-out or crystallization from the flame-retardant process allowed. Flame retarding shall be done at the mill. No flame retarding shall be acceptable after drapery fabrication without prior approval.
4. Flame retarded fabrics shall be certified as tested to NFPA 701.

2.4 EQUIPMENT AND COMPONENTS

A. Main Drape and Valance

1. The face material of the Main Drape and Valance shall meet or exceed the following criteria:
 - a. 100% Inherently Flame Retardant (IFR) polyester velour
 - b. Acceptable products:
 - 1) Rose Brand 25 oz. "Prestige"
 - 2) Dazian 25 oz. "Angelo"
 - 3) or approved equal
 - c. The color shall be selected by the Architect from the manufacturer's standard color choices.
2. 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.
 - a. Acceptable Products
 - 1) Rose Brand "Avara Lining"
 - 2) Rose Brand "Poly Chintz"
 - 3) Or equal IFR lining fabric
3. Main Drape Construction:
 - a. Two panels for bi-part action, with continuous border as indicated on drawings. Each panel finished with 75% fullness, box pleated and sewn down.
 - b. Sew with nylon thread. Color to match face material. Thread shall have no apparent sheen with relationship to the velour.
 - c. All finish webbing to be black heavyweight polypropylene, unless otherwise indicated.
 - d. 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.
 - e. Offstage edges faced back 1'-0".
 - f. Provide pocket for storage of floor block at the offstage edge of the live end of the Main Drape.
 - g. 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.

- 1) 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.
 - 2) 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.
- h. 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.
 - i. 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.
 - j. 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 ½" 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.
 - k. Size and quantity as indicated in the Drapery Schedules.
4. Valance Construction:
- a. Entire drapery shall be continuous, finished with 75% fullness, box pleated and sewn down.
 - b. Sew with nylon thread. Color to match face material. Thread shall have no apparent sheen with relationship to the velour.
 - c. All finish webbing to be black heavyweight polypropylene, unless otherwise indicated.
 - d. Offstage edges faced back 1'-0".
 - e. 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.
 - f. 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.
 - g. Mark with centerline designation on heavy-duty muslin with permanent markings, sewn securely to webbing. 2" high letters minimum.
 - h. 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.
 - i. 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 ½" 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.
 - j. Size and quantity as indicated in the Drapery Schedules.
- B. Stage Masking Draperies
1. The face material of the stage masking draperies shall meet or exceed the following criteria:
 - a. 100% Inherently Flame Retardant (IFR) polyester velour
 - b. Acceptable products:
 - 1) Rose Brand 22 oz. "Encore"
 - 2) Dazian 21 oz. "Da Vinci Velvet Plus"
 - 3) or approved equal
 2. The color of all stage masking draperies shall be black.
 3. Each panel finished without fullness. Space grommets 1'-0" on center unless otherwise indicated in Drapery Schedules.

4. Black-out drapery to be constructed in two panels for use as traveler. Continuous borders of lengths as indicated on drawings. All legs to be provided in pairs. Single panel masking curtains as indicated in the schedules.
5. Sew with nylon thread or cotton thread. Color to match face material. Thread shall have no apparent sheen with relationship to the velour.
6. All finish webbing to be black heavyweight polypropylene, unless otherwise indicated.
7. Edges of masking legs and the offstage edge of traveler panels are to be faced back with at least 1'-0" of fabric. Edges of borders and tabs with 2" hems. Hand-tack entire height with continuous catch stitching spaced 4" apart.
8. The onstage edge of traveler panels are to be faced back one full width of fabric plus 1'-0" (minimum).
9. Tops reinforced with 3½" polypropylene webbing with #2 black oxide finish brass grommets, 6" O.C.; double grommets at both ends. Center grommets on webbing. Provide double layer of webbing (3½" square) at each grommet at travelers and legs (not required for borders).
10. Masking borders to be marked with centerline designation on heavy-duty muslin with permanent markings, sewn securely to webbing. 2" high letters minimum.
11. Provide one 2'-0" black #4 cotton braided tie line at each grommet. Center tie line to be white on masking borders and tabs. Finish ends of tie lines to prevent unraveling.
12. Bottoms of all floor-length maskings 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 for full height maskings and equal to finished hem for borders. 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.
13. Bottoms of all floor-length maskings to also have a separate canvas pipe pocket for insertion of ¾" nominal pipe or other battens. Pocket to be finished even internally with face fabric hem. Ends of pocket to be left open without fastening system.
14. Sizes and quantities as indicated in the Drapery Schedules.

C. Under Gallery Masking Draperies

1. The face material of the stage masking draperies shall meet or exceed the following criteria:
 - a. 100% Inherently Flame Retardant (IFR) polyester velour
 - b. Acceptable products:
 - 1) Rose Brand 22 oz. "Encore"
 - 2) Dazian 21 oz. "Da Vinci Velvet Plus"
 - 3) or approved equal
2. The color of all stage masking draperies shall be black.
3. Each panel finished without fullness. Space grommets 1'-0" on center unless otherwise indicated in Drapery Schedules.
4. Black-out drapery to be constructed as single panel masking curtains as indicated in the schedules.
5. Sew with nylon thread or cotton thread. Color to match face material. Thread shall have no apparent sheen with relationship to the velour.
6. All finish webbing to be black heavyweight polypropylene, unless otherwise indicated.
7. Edges of masking legs and the offstage edge of traveler panels are to be faced back with at least 1'-0" of fabric. Edges of borders and tabs with 2" hems. Hand-tack entire height with continuous catch stitching spaced 4" apart.
8. The onstage edge of traveler panels are to be faced back one full width of fabric plus 1'-0" (minimum).
9. Tops reinforced with 3½" polypropylene webbing with #2 black oxide finish brass grommets, 6" O.C.; double grommets at both ends. Center grommets on webbing. Provide double layer of webbing (3½" square) at each grommet at travelers and legs (not required for borders).
10. Masking borders to be marked with centerline designation on heavy-duty muslin with permanent markings, sewn securely to webbing. 2" high letters minimum.
11. Provide one 2'-0" black #4 cotton braided tie line at each grommet. Center tie line to be white on masking borders and tabs. Finish ends of tie lines to prevent unraveling.

12. Bottoms of all floor-length maskings 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 for full height maskings and equal to finished hem for borders. 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.
13. Bottoms of all floor-length maskings to also have a separate canvas pipe pocket for insertion of ¾" nominal pipe or other battens. Pocket to be finished even internally with face fabric hem. Ends of pocket to be left open without fastening system.
14. Sizes and quantities as indicated in the Drapery Schedules.

D. Scrim

1. Material: Sharktooth Scrim, color per schedule.
2. Edges to have 3" double-stitched seams.
3. Top reinforced with 3½" polypropylene webbing, color to match face material. #2 brass grommets and black braided cotton tie lines 1'-0" O.C.; double grommets at ends. One white tie line at centerline. Mark center of drape on webbing.
4. Bottom to have 4" triple hem. Ribbon ties at 1'-0" O.C. for 1" O.D. pipe batten triple stitched to top of hem. 1'-0" polypropylene webbing sewn into ends of hems with two grommets 4" apart at corners. Provide slots in the back of the hem for installing pipe weight.
5. Provide grommets at sides, 1'-0" O.C.
6. Sizes, quantities and colors as indicated on drawings.
7. Provide 1" diameter EMT or 1" O.D. pipe for weight at bottom of scrims. Ends to be ground smooth.

E. Cyclorama

1. Material: White leno cyclorama cloth, fabricated without seams.
2. Finish webbing to be white heavyweight polypropylene.
3. Where the specified height of the cyclorama precludes the use of a single piece of leno, one horizontal seam near the top of the cyclorama will be acceptable.
4. Edges to have 3" double-stitched seams.
5. Top reinforced with 3½" polypropylene webbing. #2 brass grommets and white braided cotton tie lines 1'-0" O.C., double grommets at ends. One yellow tie line at centerline. Mark center of drape on webbing.
6. Bottom to have 4" triple hem. White ribbon ties at 1'-0" O.C. for 1" O.D. pipe batten triple stitched to top of hem. 1'-0" polypropylene webbing sewn into ends of hems with two grommets 4" apart at corners. Provide slots in the back of the hem for installing pipe weight.
7. Provide grommets at sides, 1'-0" O.C.
8. Provide 1" O.D. painted pipe for bottom of cyclorama.

F. Translucency

1. Material: Rosco "Twin White" projection screen.
 - a. 7 mil thickness
 - b. 100% PVC
2. Edges to have 3" doubled-back material with heat welded seams.
3. Top reinforced with 3½" synthetic webbing. #2 brass grommets and black braided cotton tie lines 1'-0" O.C.; double grommets at ends. One white tie line at centerline. Mark center of drape on webbing.
4. Bottom to have 4" triple wrapped pipe pocket.
5. Provide grommets at sides, 1'-0" O.C.
6. Seams welded ultrasonically.
7. Sizes and quantities as indicated on drawings.
8. Provide ¾" nominal diameter schedule 40 pipe for weight at bottom of Translucency. Ends to be threaded and provide with couplings.

G. Bounce

1. Material: Seamless Bleached Heavyweight White Muslin.

2. Finish webbing to be white heavyweight polypropylene.
3. Edges to have 3" double-stitched seams.
4. Top reinforced with 3½" polypropylene webbing. #2 brass grommets and black braided cotton tie lines 1'-0" O.C.; double grommets at ends. One white tie line at centerline. Mark center of drape on webbing.
5. Bottom to have 4" triple hem. White ribbon ties at 1'-0" O.C. for 1" O.D. pipe batten triple stitched to top of hem. 1'-0" polypropylene webbing sewn into ends of hems with two grommets 4" apart at corners.
6. Provide grommets at sides, 1'-0" O.C.
7. Provide 1" diameter EMT or 1" O.D. pipe for weight at bottom of bounce. Ends to be ground smooth.

H. Acoustic Walk Draw Draperies

1. The face material shall meet or exceed the following criteria:
 - a. 100% Inherently Flame Retardant (IFR) polyester velour
 - b. Acceptable products:
 - 1) Rose Brand 25 oz. "Prestige"
 - 2) Dazian 25 oz. "Angelo"
 - 3) or approved equal
2. The color of all acoustic walk draw draperies shall be black.
3. Drapery to be constructed in two panels for use as a walk-draw traveler. Single panel walk-draw masking curtains as indicated in the schedules. Each panel finished with 100% fullness, box pleated and sewn down.
4. Sew with nylon thread or cotton thread. Color to match face material. Thread shall have no apparent sheen with relationship to the velour.
5. All finish webbing to be black heavyweight polypropylene, unless otherwise indicated.
6. 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.
7. 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.
8. 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.
 - 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.
9. Provide all attachment hardware to mount drapery to curtain track carriers provided under section 116133.
10. Sizes and quantities as indicated in the Drapery Schedules.

I. Acoustic Backdrop Draperies

1. The face material shall meet or exceed the following criteria:
 - a. 100% Inherently Flame Retardant (IFR) polyester velour
 - b. Acceptable products:
 - 1) Rose Brand 25 oz. "Prestige"
 - 2) Dazian 25 oz. "Angelo"
 - 3) or approved equal
2. The color of all mirror masking draperies shall be selected by Architect.
3. Acoustic Backdrop Drape Construction:
 - a. Two panels for bi-part action, with continuous border as indicated on drawings. Each panel finished with 100% fullness, box pleated and sewn down.
 - b. Sew with nylon thread. Color to match face material. Thread shall have no apparent sheen with relationship to the velour.
 - c. All finish webbing to be black heavyweight polypropylene, unless otherwise indicated.

- d. 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.
 - e. Offstage edges faced back 1'-0".
 - f. 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.
 - g. At center of each pleat, 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.
 - h. 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.
 - 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. Size and quantity as indicated in the Drapery Schedules.
- J. Electric Borders
- 1. Material: Black "Heatstop 1832" as manufactured by W.E. Palmer Company or approved equal.
 - 2. Construction as for masking borders.
- K. Bottom Pipe
- 1. Provide bottom pipe for draperies as indicated herein.
- L. Storage Hampers
- 1. Provide storage hampers in sizes and quantities defined in the Drapery Schedules.
- M. Storage Bags
- 1. Provide heavy-duty canvas drapery storage bags in sizes and quantities defined in the Drapery Schedules.

2.5 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. 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:
 - 1. Manufacturer's Name
 - 2. Date of manufacture
 - 3. Finished size of goods
 - 4. Recommended cleaning instructions
- C. Fabric runs to be full height without joints or intermediate seams.
- D. 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.
- E. Nap of velour sewn down unless otherwise specified.
- F. Ends of chain and pipe pockets to be closed with 1½" wide hook and loop fasteners minimum.
- G. Hang-out and Straightening
 - 1. All draperies, with the exception of cycloramas and scrimms, 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. 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

J.R. Clancy Incorporated
7041 Interstate Island Road
Syracuse, NY 13209-9713
Tel: (800) 836-1885

LVH Entertainment Systems
1801 Highland Avenue,
Unit E
Duarte, CA 91010
Tel: (805) 278-4584

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

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.

3.2 EXAMINATION

- A. Verification of Conditions: Contractor must examine areas and conditions under which the equipment is to be installed and shall 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. Install all work securely, complete with all bolts, nuts, washers, clips, fittings, supports, and other items required for proper installation and operation.

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. Arrange for all tests and inspections required by the General Requirements.

3.5 ADJUSTING

- A. Upon installation and in accordance with the Owner's and the Theatrical Rigging Contractor'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.

3.6 CLEANING

- A. 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. Installed equipment to be operated for approval and inspected for quality by the Architect and the Owner.
 2. Adjustments or modifications shall be made as directed by the Architect and the Theatre Consultant.
 3. Cost of re-inspection and additional testing by the Architect and/or 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, the Owner's designated staff or representatives shall be instructed in the use, care and maintenance of all items.
 2. Deliver all copies of approved Operations Manual to Owner prior to the instruction session, and review it as part of that session.
 3. Instruction shall be by technical staff of the Contractor.
 4. Instruction to be scheduled in conformance with project construction schedules and the availability of the Architect and the Owner.

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.

END OF SECTION

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. Studio 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
 - f. Theatrical lighting control consoles and peripherals
 - 1) Wireless focus remote systems
 - 2) Theatrical control panels and receptacles
 - 3) Video display monitors
 - g. Architectural lighting control systems
 - 1) House lighting controls
 - 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. Control Room furniture
 - j. 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 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.
 - f. 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 116113 – Orchestra Shell Enclosure
 - 2) Section 116133 – Theatrical Rigging
 - 3) Section 116173 – Theatrical Lighting Fixtures and Accessories
 - 4) Section 116183 – Theatrical Audio Video Systems
 - 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 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
 - l. Division 27 – Communications
 - 1) Structured cabling systems
 - 2) 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. Valade Jazz Center - Network Control Infrastructure
 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. <<TBD>>

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 1008
 - b. Institute of Electronic and Electrical Engineers
 - 1) IEEE 802.3af

- 2) IEEE 802.3at
 - 3) IEEE 802.3z
 - c. Illuminating Engineering Society of North America
 - d. American National Standards Institute
- ANSI E1.11 - 2008, USITT DMX512-A
- ANSI E1.17-2010, Architecture for Control Networks
- ANSI E1.20, Remote Device Management over DMX512 Networks
- e. Electronic Industries Alliance/Telecommunications Industry Association
 - 1) ANSI/TIA/EIA 568-A
- Category 5e Standard
- 2) ANSI/TIA/EIA-568-B
 - 3) 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 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 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.
 - c. Network data system
 - d. Network connection devices
 - e. Theatrical lighting control console
 - f. Architectural lighting control system
 - 1) DMX bypass for LED source house lighting
 - g. Architectural lighting control panels
 - h. Cue Light System
 - i. Dimmed and switched power distribution devices
 - 1) Plugging strips
 - 2) Plugging boxes
 - 2. Studio 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.
 - b. Network data system
 - c. Network connection devices

- d. Theatrical lighting control console
 - 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
 - h. Control room furniture
- 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.
16. Standard advertised product dimensions are to be considered maximum and are not to be increased. Reduced sizes are 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 55dbc 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

2.5 DMX CONTROLLED PANELBOARDS

A. DMX Relay Panel

1. Panels shall provide over-current circuit protection and remote on and off circuit control utilizing mechanically held relays in a single wall-mounted enclosure.
2. Panels shall support single, double, and triple pole relays, and include control electronics, electronics power supply, and isolated technical ground bar.
3. Panels shall support 300W phase-adaptive dimmer modules at any single pole circuit position.
4. All panels and components shall be ETL or UL Listed.
5. Panels shall be no larger than 20" wide x 6" deep x 70" high.
6. 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.
7. Panels shall be convection cooled.
8. 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.
9. Panels shall have Main Circuit Breaker protection on input feed.
10. All line, neutral and ground terminals shall accept up to 6 AWG wire.

11. The individual relays shall contain mechanically held contacts with ampacity ratings of 20 amps at up to 277AC, as required.
12. Each relay shall have an integral manual override switch with on/off status indication.
13. 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
14. 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.
15. The panel shall receive DMX512 control protocol and sACN. Up to two additional control protocols, including 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.
16. Panels shall support discrete addressing of each relay.
17. 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components.
18. A voltage barrier shall be provided to separate line voltage and control voltage sections of the panel.
19. Provide:
 - a. Electronic Theatre Controls Unison Echo Relay Panel Mains Feed in configurations and with accessories as listed in the Appendix.

NETWORK DATA SYSTEM

B. 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. Network Control Racks (CR)
 - a. Network Control Racks (CR) shall contain network components and auxiliary equipment including but not limited to:
 - 1) Network switches, patch panels, and cable management, as required.
 - 2) Network devices, including network nodes and taps, as required.
 - 3) DMX Combine Merger and Splitter Units, as required
 - 4) Architectural processors, as required
 - 5) Uninterruptible power supplies
 - 6) Additional equipment as indicated on Drawings.
7. Production Control Panel (PCP)
 - a. The Production Control Panel (PCP) shall contain the following elements:
 - 1) Rack Identification panel with rack name and location.
 - 2) Task Light Panel
 - 3) House and Work Lighting Control panel.
 - 4) Additional Theatrical Lighting equipment as indicated on Drawings.
 - 5) Uninterruptible power supply rated to power equipment contained in this rack for 30 minutes.
 - 6) Blank and vent panels as required.
 - 7) 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.
 - b. Confirm space requirements with other affected contractors in writing prior to fabrication. Coordinate wall backing requirements for mounting with General Contractor.

C. Network Components:

1. Network switches shall have the following characteristics and functions:
 - a. Switches shall contain (24) dual speed auto-sensing ports, supporting both 100BASE-T and 10BASE-T and PoE per IEEE 802.3af or 802.3at as appropriate.
 - b. Switches shall support IEEE 802.3i Type 100BASE-T standard.
 - c. Switches shall be rack-mounted in standard 19" racks.
 - d. 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.
 - e. Switches shall have UTP ports on its front face for connecting to nodes and taps via standard 19" patch panel.
 - f. Should Ethernet wire runs exceed 300 feet, provide switches with fiber ports equal to the number of fiber runs in the system.
 - g. 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

D. 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 50/125 μ m fiber optic cable as required to support network components.
 - c. The cable must exceed the IEEE802.3z Gigabit Ethernet Fiber specification for 50/125 μ m Fiber.
 - 1) For Gigabit Ethernet 1000sx over 50/125 μ m fiber, a modal bandwidth of 500mHz per km in the 850nm wavelength with 500m minimum distance is required.
 - 2) For Gigabit Ethernet 1000lx over 50/125 μ m 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. 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:
CommScope 55N4 Ultra II Enhanced Category 5 UTP cable
Belden 1583A
- 2) For plenum rated applications;
CommScope 5504M Ultra II Enhanced Category 5 UTP cable (for plenum rated applications).

Belden 1585A

E. Network Services Gateway

1. The Network Services Gateway shall be a microprocessor-based unit for automatic configuration, monitoring and management of an integrated lighting network system. The gateway shall:
 - a. Communicate with lighting network devices over Ethernet using standard Category 5e cabling and Ethernet switches.
 - b. Support multiple protocols, including ACN, DHCP, DNS, and FTP.
 - c. Support real-time logging and notification of system errors.
 - d. Provide storage of system device configurations.
 - e. Allow creation of user-defined reports.
2. Enclosure shall include a backlit graphic LCD display for identification and status reporting.
3. Provide with rack-mounting hardware and power supply.
4. Provide:
 - a. Electronic Theatre Controls Net3 Conductor.

F. 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:
 - 1) ETC Unison Paradigm

G. 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. Studio Theatre
 - c. Valade Jazz Center

2.6 NETWORK GATEWAYS

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 80203.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

2.7 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. Assembly shall have a sheet metal back box and faceplate, finished flat black.
 - a. Provide flush mount or surface back box and properly sized faceplate as required for each location shown on drawings.
 - b. Faceplate shall match edges of back box in surface mount conditions.
4. See drawings for device locations and control device schedules for device type, mounting type, and receptacle types and quantities.
5. Receptacles:
 - a. 20A Edison (NEMA 5-20 R) duplex panel mounted receptacles
 - 1) All receptacles shall be of the same manufacture
 - 2) Color to be 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:
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:
Neutrik opticalCON receptacles
 - d. Multi-Pin receptacles
 - 1) Provide ruggedized multi-pin receptacles to mate with cord-mounted connector on device type HLP, portable houselight controller.
6. 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.
- 7. 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.
 - 5. 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.

2.8 THEATRICAL LIGHTING CONTROL CONSOLES

- A. Lighting Control Console
 - 1. Console shall be microprocessor-based system designed specifically for theatrical lighting control application. Consoles shall be engineered for ease and clarity of operation and shall incorporate visual display to assist operator in modes of operation.
 - 2. The console shall be capable of operation in blind (preview/non-live) and shall also be capable of operation in live (stage) mode.
 - 3. Console shall be able to organize data for channels other than those associated with dimmer levels through the use of special grouping or numbering schemes. Simply flagging channels with a new color in the video display shall not be acceptable.
 - 4. Console shall graphically organize information, particularly for automated luminaires, to allow easy identification of the large groups of channel numbers involved with such fixtures. Assignment of pan and tilt functions of automated luminaires shall be supported by either level wheel, track pad or a mouse associated with the console. In addition, the pan and tilt axis of multiple luminaires shall be able to be assigned to a single device, such as a level wheel, track ball or mouse, to allow multiple automated fixtures to track together to a single point on stage.
 - 5. Console shall be capable of pan and tilt operation through external devices with virtual focus software (such as Wysiwyg) or automated tracking devices (such as BlackTrax).
 - 6. The console shall allow cues to be modified while they are running. The console shall support color print outs to mimic color displayed on video screens.
 - 7. Console shall support full bi-directional RDM communication with compatible devices.
 - 8. Console shall have Ethernet, USB, DMX512/RDM, MIDI In/Out, and RS-232 ASCII port interfaces.
 - 9. The Console and central processors (if needed in the system) shall be connected through uninterruptible power supplies as needed to protect console and network operations for at least 30 minutes in the event of power failure.
 - 10. The console shall be provided with all currently advertised features and components indicated in the most recently published product literature plus features described in System Description.
 - 11. The console shall be capable of controlling the lighting network by being plugged directly into any network tap.
 - 12. Provide one Theatrical Lighting Main Control Console for each of the spaces listed below:

- a. Proscenium Theatre
 - 1) Electronic Theatre Controls – Gio – 24K with 2 x 10 fader wing
- b. Studio Theatre
 - 1) Electronic Theatre Controls – Gio@5 – 24K with 2 x 10 fader wing
- c. Valade Jazz Center
 - 1) Electronic Theatre Controls – Ion Xe 20 – 12K

B. Wireless Focus Remote Unit

1. Provide Wireless Remote Focus Unit system with all currently advertised features and components indicated in the most recently published product literature.
2. System shall consist of a handheld personal digital assistant equipped with a wireless access card for operation on an 802.11b wireless Ethernet network. Wireless access card must be compatible with wireless access points (WAP) provided with the theatrical lighting Ethernet network.
3. Remote shall “call up” dimmers and channels from remote locations for lamp or focus checks without an operator at the main console.
4. Remote shall be capable of calling up and running through pre-recorded cues and triggering macros.
5. Remote shall not lose data if its battery becomes depleted.
6. Remote shall operate with the main console.
7. Remote shall be provided with a charging cradle.
8. Provide quantities as listed in the Appendix.

C. Video Monitors

1. Monitors shall be high resolution; 17” color flat-screen multi-touch capable LCD monitors capable of displaying all console video display information. Monitors shall have connectors to mate directly with Remote Video Interface and shall have front mounted controls for contrast, brightness, vertical hold, and horizontal hold.
2. Provide: quantity per Appendix.
 - a. Furnish 1 - 10' and 1 - 25' video extension cable for each monitor.
 - b. Furnish 1 - 10' and 1 - 25' power extension cable for each monitor.
 - c. Protective Cover:
 - 1) Provide one protective cover for each monitor.

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. The system shall control LED architectural lighting, DMX relay-controlled work lighting and DMX controlled switching for theatrical circuits as shown on the drawings. 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.
2. When in use, the theatrical console shall override preset levels on a highest takes precedence basis and shall directly control only those dimmed architectural circuits within the same performance space.
3. The dimmed circuits in the performance spaces shall operate independently of the dimmed circuits in the lobbies and public spaces. This system shall not control the lobbies and public spaces.

B. Architectural Lighting Control System

1. The System 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. The System shall be configured to allow multiple active presets to control architectural lighting, work lights, and theatrical lights simultaneously through the use of multiple room assignments.

3. Provide sufficient quantity of system processors to have the ability to “snapshot” DMX levels from Theatrical lighting console and record in to architectural preset for all DMX assigned values including dimmed circuits, relay circuits, moving lights and theatrical lights in each system.
4. Switching between panels shall not cause flicker or change in lighting levels when setting on panels or House Lighting master station are identical.
5. The system shall be a microprocessor based lighting control system. System operating program shall be stored in electrically erasable programmable read only memory (EEPROM).
6. 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.
7. Provide control system configuration software operating on a PC platform to allow configuration and preset level setting.
8. Provide:
 - 1) Electronic Theatre Controls Unison Paradigm System

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 gateways 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. Each unit shall provide a full universe (512 channels) of DMX control.
8. The unit shall be UL924 listed.
9. Outputs shall be configurable as normally open or normally closed.
10. 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. Control device back boxes, where required, shall be standard deep masonry boxes by Square D or equal.
3. Controls shall be low voltage type and use N.E.C. Class II, low-voltage wiring.
 - a. Only Belden control cables shall be acceptable.
4. 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.
5. 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.
6. 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.
7. 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 '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 as follows to allow control of:
 - 1) Master levels of each recorded preset.
 - 2) Individual dimmed channel and switched work light channel levels/status.
 - 3) Preset, level and fade time recording.

- 4) Preset selection and playback.
 - 5) 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, House Panic and Work Lighting Systems as specified herein.
 4. Provide EAO Series 31 Switches as specified above for PANIC, NORMAL controls.
 5. Provide flush, surface, or 19" rack mount back box as required for each mounting condition shown on drawings.
 6. Provide anodized aluminum or painted sheet metal cover plate with chamfered edges, color as per Architect.
- 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. 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. Provide black sheet metal back box. Do not exceed 4" in depth without prior approval.
 - a. Provide surface or flush mount back box as required for each mounting condition shown on drawings.
 4. Provide anodized aluminum or painted sheet metal cover plate with chamfered edges, color as per Architect. Cover shall be flush with back box edges in surface mount condition.
 5. LED indicators in switches shall indicate the active preset on the panel.
 6. 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 constructed of sheet metal, finished flat black. Provide requisite mounting holes, conduit knockouts, etc.
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:
Union Connector 20-2P&G series
Rosco 2000 series
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:

- Leviton 8300-E
- 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:
 - Leviton 8319C
 - Legrand/Pass & Seymour PS5369XHG
 - Hubbell 8319C
 - Cooper (Arrow/Hart) 8369
- d. 20A Twist-Lock (NEMA L5-20R) single flush mount receptacles
 - 1) All receptacles shall be of the same manufacture
 - 2) Nylon body
 - 3) Color: Black
 - 4) Provide:
 - (a) Leviton 2310
 - (b) Legrand/Pass & Seymour L520R
 - (c) Hubbell 2310
 - (d) Cooper CWL520R
- e. 20A Twist-Lock (NEMA L5-20R) single flush flange mount receptacles
 - 1) All receptacles shall be of the same manufacture
 - 2) Nylon body
 - 3) Color: White
 - 4) Provide:
 - (a) Leviton 2316
 - (b) Hubbell 2316
 - (c) Cooper CWL520FO
- f. 20A 208V Twist-Lock (NEMA L6-20R) single flush mount receptacles
 - 1) All receptacles shall be of the same manufacture
 - 2) Nylon body
 - 3) Color: Black
 - 4) Provide:
 - (a) Leviton 2320
 - (b) Legrand/Pass & Seymour L620R
 - (c) Hubbell 2320
 - (d) Cooper AHL620R
- g. 20A 208V Twist-Lock (NEMA L6-20R) single flush flange mount receptacles
 - 1) All receptacles shall be of the same manufacture
 - 2) Nylon body
 - 3) Color: White
 - 4) Provide:
 - (a) Leviton 2326
 - (b) Hubbell 2326
 - (c) Cooper AHL620FO
- h. 20A 3-phase, 4 Wire plus Ground Twist-Lock (NEMA L21-20R) single flush mount receptacles
 - 1) All receptacles shall be of the same manufacture
 - 2) Nylon body
 - 3) Color: Black
 - 4) Provide:
 - (a) Leviton 2510
 - (b) Legrand/Pass & Seymour L2120R
 - (c) Hubbell 2510

- (d) Cooper CWL2120R
 - i. 20A 3-phase, 4 Wire plus Ground Twist-Lock (NEMA L21-20R) single flush flange mount receptacles
 - 1) All receptacles shall be of the same manufacture
 - 2) Nylon body
 - 3) Color: White
 - 4) Provide:
 - (a) Leviton 2516
 - (b) Hubbell 2516
 - j. 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:
 - (a) Single cables with double basket weave strain relief
 - (b) Multiple individual cords with clamping cable glands
 - 3) Multi-pin receptacles and plugs shall be 19-pin connectors wired for 6 circuits with dedicated line and neutral connections and 7 ground wires.
 - 4) Provide:
 - (a) Veam VSC
 - (b) 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) lamacoid 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. Plug Boxes with Pigtails - Type 'PBP'**

1. Provide plug boxes 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. Label each receptacle with appropriate switched circuit designation and DMX address or dimmer designation indicated on distribution schedule and drawings.
- D. Plugging Strip with Flush Receptacles – Type ‘PSR’
1. Provide plugging strips of standard plug batten construction 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.
- E. 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. Label each receptacle with appropriate switched circuit designation and DMX address or dimmer designation indicated on distribution schedule and drawings.
 4. Provide with integral control device panels where indicated on drawings.
 5. 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.
- F. 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.
- G. 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.
- H. Flexible Cable Terminal Box - Type ‘TB’
1. Provide junction boxes between conduit and flexible multi-cable feeding batten-mounted connector strips. See drawings for device locations and circuit quantities.
 2. All wiring connections shall be internal to the device.
 3. Provide feed through wiring terminals with individual circuit labels.

4. Provide with low voltage distribution system compatible with DMX and/or Ethernet protocols, as indicated on drawings.
5. Provide appropriate strain relief at all flexible cable entries.

2.12 CONTROL ROOM FURNITURE

- A. Adjustable Height Desk
 1. Provide control room desks for lighting and stage management control positions
 2. Height adjustable from 28" to 47"
 3. Electric lift for height adjustment
 4. Castered base with locking casters
 5. 150lb. lift capacity
 6. Metal understructure with black work surface
 7. Integral cable tray
 8. 29" minimum work surface depth
 9. Widths and quantities as listed in the Appendix
 10. Provide:
 - a. Ergotron Elevate Single Surface
 - b. Or approved equal

2.13 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.

2.14 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 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. Wood furniture/cabinet work for control desks acceptable with prior approval.
- H. Operating elements shall be mechanically safe and electrically "dead".
- I. 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.
- J. 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.
- K. Operating instructions shall be similarly engraved and appropriately located on designated equipment.
- L. 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.
- M. All internal wiring shall be factory completed and clearly marked.
- N. Field connections shall be made by connector devices and cables as specified in preceding sections.
- O. Dimmer modules, dimmer controllers and other plug-in components may have spade lug and/or receptacle devices for connection.
- P. Control relays wherever possible shall be the glass or polycarbonate enclosed plug-in type. Relays shall be acoustically damped.
- Q. 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.
- R. All wire sizes and insulation to comply with UL standards and local codes and meet or exceed electronics industry standards.
- S. All wiring to be harnessed and bound. No loose or randomly routed wires permitted.
- T. All printed circuit cards to be suitably racked with numbered and indexed guides. Legends to be provided on panel door.
- U. Key all components in this section with locks or key switches alike. Provide six keys minimum.
- V. 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.
- W. 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

LVH Entertainment Systems
1801 Highland Avenue,
Unit E
Duarte, CA 91010
Tel: (805) 278-4584

Texas Scenic Co.
8053 Potranco Road
San Antonio, TX 78251
Tel: 210-684-0091

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

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.

<<APPENDIX NOT ISSUED AS A PART OF DESIGN DEVELOPMENT SUBMISSION>>

END OF SECTION

**SECTION 116173
THEATRICAL LIGHTING FIXTURES AND ACCESSORIES**

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Furnish the following major elements and associated accessories:
 - a. Theatrical lighting fixtures and accessories
 - 1) LED Source Fixtures
 - 2) Incandescent Source Fixtures
 - 3) Automated Fixtures
 - 4) Followspots
 - 5) Accessories
 - 6) Portable Stage Cable
 - 7) Lamps
 - 8) Hardware
 - 9) Color frames, clamps and safety cables
2. Provide all materials, components and services required to provide the work as specified herein, elsewhere in the project documents and/or as shown on related drawings.
3. Consult and coordinate with other affected work and contractors throughout the course of the work contained herein.

B. Products Supplied But Not Installed Under This Section

1. Lighting fixtures and accessories will be delivered to the site, unpacked and assembled for installation by the Owner.

C. 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 11 – Equipment
 - 1) Section 116133 – Theatrical Rigging
 - 2) Section 116163 – Theatrical Lighting Dimming and Control
 - c. Division 26 – Electrical

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 a unit price for each line item identified in the Appendix to this specification.
 - a. The Owner may adjust quantities before award of bid based on unit pricing.

C. Alternates

1. Provide separate price information for material and labor associated with the following equipment and systems:
 - a. <<TBD>>
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. <<TBD>>

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 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 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. 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.

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. 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.
2. The unpacking and installation of Theatrical Lighting Fixtures and Accessories shall not occur until the site is continuously secure, free of dust and debris, and climate controlled.

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. 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.
- H. Shop Drawings:
1. Provide shop drawings on D size minimum (24" x 36") sheets.
 2. Provide complete, fully dimensioned, large-scale shop drawings of all non-standard components. Include item-identifying number.
 3. Provide indications by arrow and boxed caption of all variations from contract drawings and specifications, except where variation is indicated as acceptable.
 4. Provide a full Bill of Materials to be supplied, including quantities, manufacturer, manufacturer's part number, manufacturer's catalog number, etc. Clearly indicate the type and quantity of lamps being supplied for each fixture.
 5. All custom elements shall be engineered. Provide approved drawings stamped by a Professional Engineer licensed in the project jurisdiction. The engineer shall verify that the equipment supplied under this section meets or exceeds the design criteria of this specification.
- I. Samples
1. Submit samples items for approval within 14 days of Architect's written request. These items may include, but are not limited to:
 - a. Individual fixtures
 - b. Mounting hardware
 - c. Connectors

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 inventories of all equipment provided.

4. Submit operation and maintenance manuals with the final inventories. 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, which may need periodic replacement.
 - 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. 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. Furnish a package of spare parts for user-serviceable portions of the equipment.
 2. Label all spare parts with manufacturer's part number, designation and description, and location(s) where used.
 3. Furnish durable, clearly labeled storage containers for spare parts, including special static free containers for electronically sensitive parts.

1.8 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Refer to Division 01 – General Requirements.
- B. Qualifications:
1. All equipment within this specification is to be the responsibility of a single Contractor. Provision of such equipment shall comprise no less than 90% of the Contractor's business.
 2. The Contractor shall be a factory-authorized distributor and servicer for all of the specified equipment.
 3. Contractor shall maintain a full-time Manufacturer-trained and certified field technician available on an emergency basis within 2 hours travel of the project location.
 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 of the responsibility for providing properly functioning theatrical lighting fixtures and accessories 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 equipment and 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 Protections

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 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 conditions at job site. Promptly report variations and obstructions to the Architect. All additions and/or corrections are to be requested prior to installation.

B. Environmental Requirements

1. Coordinate all environmental requirements for all materials provided and installed under this contract.

1.11 WARRANTY

A. Comply with the warranty requirements of Division 01 and the following.

B. 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. 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.

D. 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. The following listed manufacturers are indicative of the quality and features for the equipment specified herein:

1. LED Source Fixtures
 - a. Electronic Theatre Controls
 - b. Altman Stage Lighting
2. Incandescent Source Fixtures
 - a. Electronic Theatre Controls
 - b. Altman Stage Lighting

3. Automated Fixtures
 - a. Martin
 - b. High End Systems
 - c. Vari-Lite
4. Followspots
 - a. Lycian Stage Lighting
 - b. Robert Juliat
5. Accessories
 - a. City Theatrical
 - b. Fehr Brothers
 - c. The Light Source
 - d. Electronic Theatre Controls
6. Lamps
 - a. General Electric
 - b. Osram
 - c. Sylvania
 - d. Ushio
 - e. LEDs per fixture manufacturer standard
7. Portable Stage Cable
 - a. Lex Products
 - b. A.C.T. Lighting
 - c. C.B.I. Professional Wiring Systems
8. Hardware
 - a. City Theatrical

B. 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.

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).

2.2 MATERIALS

- A. All equipment and components shall be new and complete. No used or reconditioned equipment shall be acceptable.
- B. All mounting hardware shall be included.
 1. All bolts and fasteners required to mount equipment to mounting hardware shall be Grade 5 or better.
- C. Housings shall be sheet steel, cast aluminum or a combination of both, in thicknesses and gauges conforming to prevailing industry standards.
- D. Fixtures shall be adequately ventilated for the largest lamp that the instrument is designed to accommodate. Vents shall be baffled to prevent emission of direct light from filament and reflector and to reduce to a minimum the stray light and secondary reflections.
- E. Unless otherwise specified, reflectors shall be molded borosilicate reflector with multiple dichroic layers.
- F. The exterior finish of all instruments shall be black high temperature epoxy paint. The interior finish in all instruments shall be flat black except for sockets and reflectors.
- G. All lenses shall be heat-resistant, of size, type and spread specified.
- H. All profile spotlights shall be provided with a positively locking means for adjusting the source to lens relationship to provide proper centering of the optical train.
- I. All fixtures shall be supplied with lamps as specified, shipped to the job site (in their original packing) in clearly marked cartons, indicating lamp type, size and the space for which they are intended.

2.3 LED PROFILE SPOTLIGHTS, COLOR MIXING

- A. 19 Degree Profile LED source color mixing spotlight shall have the following characteristics:
 1. Profile spotlight lighting fixture utilizing minimum of 60 LED array providing 7 colors
 2. Beam angle of 18 degrees
 3. Field angle of 19 degrees
 4. Optics shall utilize enhanced definition lens tube
 5. LED "lamp life" of 20,000 hours
 6. Fixture form factor similar in size and shape to incandescent profile spotlights
 7. Neutrik powerCON in and through receptacles
 8. Power cable terminated with parallel blade U-ground Edison connector
 9. Input voltage of 100 to 240VAC at 50/60HZ
 10. 15-bit dimming engine
 11. Fixture parameters controlled via DMX512
 12. 15 control addresses
 13. DMX512 in and through connectors
 14. Die cast aluminum fixture construction
 15. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat

16. 4 independent framing shutters with 25 degree minimum rotation of shutter assembly with the fixture
 17. Slot for pattern holder or mechanical iris unit
 18. C-Clamp for attachment of fixture to pipes of up to 3"
 19. UL or ETL approved
 20. Integral low noise fan controlled by on-board thermostat
 21. Provide accessories as defined in the appendix to this specification
 22. Provide in quantities defined in the appendix to this specification
 23. Provide Electronic Theatre Controls, Source Four LED Series 2 Lustr 19 Degree or approved equal
- B. 26 Degree Profile LED source color mixing spotlight shall have the following characteristics:
1. Profile spotlight lighting fixture utilizing minimum of 60 LED array providing 7 colors
 2. Beam angle of 25 degrees
 3. Field angle of 27 degrees
 4. Optics shall utilize enhanced definition lens tube
 5. LED "lamp life" of 20,000 hours
 6. Fixture form factor similar in size and shape to incandescent profile spotlights
 7. Neutrik powerCON in and through receptacles
 8. Power cable terminated with parallel blade U-ground Edison connector
 9. Input voltage of 100 to 240VAC at 50/60HZ
 10. 15-bit dimming engine
 11. Fixture parameters controlled via DMX512
 12. 15 control addresses
 13. DMX512 in and through connectors
 14. Die cast aluminum fixture construction
 15. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat
 16. 4 independent framing shutters with 25 degree minimum rotation of shutter assembly with the fixture
 17. Slot for pattern holder or mechanical iris unit
 18. C-Clamp for attachment of fixture to pipes of up to 3"
 19. UL or ETL approved
 20. Integral low noise fan controlled by on-board thermostat
 21. Provide accessories as defined in the appendix to this specification
 22. Provide in quantities defined in the appendix to this specification
 23. Provide Electronic Theatre Controls, Source Four LED Series 2 Lustr 26 Degree or approved equal
- C. 36 Degree Profile LED source color mixing spotlight shall have the following characteristics:
1. Profile spotlight lighting fixture utilizing minimum of 60 LED array providing 7 colors
 2. Beam angle of 33 degrees
 3. Field angle of 35 degrees
 4. Optics shall utilize enhanced definition lens tube
 5. LED "lamp life" of 20,000 hours
 6. Fixture form factor similar in size and shape to incandescent profile spotlights
 7. Neutrik powerCON in and through receptacles
 8. Power cable terminated with parallel blade U-ground Edison connector
 9. Input voltage of 100 to 240VAC at 50/60HZ
 10. 15-bit dimming engine
 11. Fixture parameters controlled via DMX512
 12. 15 control addresses
 13. DMX512 in and through connectors
 14. Die cast aluminum fixture construction
 15. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat
 16. 4 independent framing shutters with 25 degree minimum rotation of shutter assembly with the fixture

17. Slot for pattern holder or mechanical iris unit
 18. C-Clamp for attachment of fixture to pipes of up to 3"
 19. UL or ETL approved
 20. Integral low noise fan controlled by on-board thermostat
 21. Provide accessories as defined in the appendix to this specification
 22. Provide in quantities defined in the appendix to this specification
 23. Provide Electronic Theatre Controls, Source Four LED Series 2 Lustr 36 Degree or approved equal
- D. 50 Degree Profile LED source color mixing spotlight shall have the following characteristics:
1. Profile spotlight lighting fixture utilizing minimum of 60 LED array providing 7 colors
 2. Beam angle of 48 degrees
 3. Field angle of 50 degrees
 4. Optics shall utilize enhanced definition lens tube
 5. LED "lamp life" of 20,000 hours
 6. Fixture form factor similar in size and shape to incandescent profile spotlights
 7. Neutrik powerCON in and through receptacles
 8. Power cable terminated with parallel blade U-ground Edison connector
 9. Input voltage of 100 to 240VAC at 50/60HZ
 10. 15-bit dimming engine
 11. Fixture parameters controlled via DMX512
 12. 15 control addresses
 13. DMX512 in and through connectors
 14. Die cast aluminum fixture construction
 15. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat
 16. 4 independent framing shutters with 25 degree minimum rotation of shutter assembly with the fixture
 17. Slot for pattern holder or mechanical iris unit
 18. C-Clamp for attachment of fixture to pipes of up to 3"
 19. UL or ETL approved
 20. Integral low noise fan controlled by on-board thermostat
 21. Provide accessories as defined in the appendix to this specification
 22. Provide in quantities defined in the appendix to this specification
 23. Provide Electronic Theatre Controls, Source Four LED Series 2 Lustr 50 Degree or approved equal
- E. 70 Degree Profile LED source color mixing spotlight shall have the following characteristics:
1. Profile spotlight lighting fixture utilizing minimum of 60 LED array providing 7 colors
 2. Beam angle of 65 degrees
 3. Field angle of 70 degrees
 4. LED "lamp life" of 20,000 hours
 5. Fixture form factor similar in size and shape to incandescent profile spotlights
 6. Neutrik powerCON in and through receptacles
 7. Power cable terminated with parallel blade U-ground Edison connector
 8. Input voltage of 100 to 240VAC at 50/60HZ
 9. 15-bit dimming engine
 10. Fixture parameters controlled via DMX512
 11. 15 control addresses
 12. DMX512 in and through connectors
 13. Die cast aluminum fixture construction
 14. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat
 15. 4 independent framing shutters with 25 degree minimum rotation of shutter assembly with the fixture
 16. Slot for pattern holder or mechanical iris unit
 17. C-Clamp for attachment of fixture to pipes of up to 3"
 18. UL or ETL approved

19. Integral low noise fan controlled by on-board thermostat
20. Provide accessories as defined in the appendix to this specification
21. Provide in quantities defined in the appendix to this specification
22. Provide Electronic Theatre Controls, Source Four LED Series 2 Lustr 70 Degree or approved equal

2.4 LED WASH FIXTURES, COLOR MIXING

- A. LED source color mixing wash fixture shall have the following characteristics:
1. Wash lighting fixture utilizing minimum of 60 LED array providing 6 colors plus white
 2. Beam angle of 8 degrees
 3. Field angle of 17 degrees
 4. LED "lamp life" of 50,000 hours
 5. Neutrik powerCON in and through receptacles
 6. Power cable terminated with parallel blade U-ground Edison connector
 7. Input voltage of 120 to 240VAC at 50/60HZ
 8. Power consumption of 161W at full intensity
 9. 15-bit dimming engine
 10. Fixture parameters controlled via DMX512
 11. 15 control addresses
 12. DMX512 in and through connectors
 13. Die cast aluminum fixture construction
 14. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat
 15. C-Clamp for attachment of fixture to pipes of up to 3"
 16. UL or ETL approved
 17. Integral low noise fan controlled by on-board thermostat
 18. Provide secondary lenses as defined in the appendix to this specification
 19. Provide accessories as defined in the appendix to this specification
 20. Provide in quantities defined in the appendix to this specification
 21. Provide Electronic Theatre Controls, Desire D60 Lustr+ or approved equal

2.5 LED CYCLORAMA WASH FIXTURES, COLOR MIXING

- A. LED Cyclorama Fixture
1. Wash lighting fixture designed for lighting vertical surfaces utilizing RGBW LED arrays
 2. Reflector design with specular finish for even coverage of vertical surfaces
 3. Neutrik powerCON in and through receptacles
 4. Power cable terminated with parallel blade U-ground Edison connector
 5. Input voltage of 120 to 240VAC at 50/60HZ
 6. Power consumption of 100W at full intensity
 7. Integral dimming engine
 8. Fixture parameters controlled via DMX512 or RDM
 9. 4 control addresses
 10. DMX512 in and through connectors
 11. Lightweight aluminum fixture construction in black finish
 12. C-Clamp for attachment of fixture to pipes of up to 3" for hanging
 13. Floor Trunnions for groundrow use
 14. Convection cooled
 15. UL or ETL approved
 16. Provide accessories as defined in the appendix to this specification
 17. Provide in quantities defined in the appendix to this specification
 18. Provide Altman Stage Lighting, Spectra Cyc 100 or approved equal.
- B. LED Striplight
1. Wash lighting fixture designed for lighting vertical surfaces utilizing RGBA LED arrays
 2. 6-foot fixture length
 3. Neutrik powerCON in and through receptacles
 4. Power cable terminated with parallel blade U-ground Edison connector

5. Input voltage of 120 to 240VAC at 50/60HZ
6. Power consumption of 660W at full intensity
7. Integral dimming engine
8. Fixture parameters controlled via DMX512 or RDM
9. 4 control addresses
10. DMX512 in and through connectors
11. Lightweight aluminum fixture construction in black finish
12. C-Clamp for attachment of fixture to pipes of up to 3" for hanging
13. Floor Trunnions for groundrow use
14. Integral low noise fan controlled by on-board thermostat
15. UL or ETL approved
16. Provide accessories as defined in the appendix to this specification
17. Provide in quantities defined in the appendix to this specification
18. Provide Chroma-Q Color Force 72 or approved equal.

2.6 LED SOURCE BROAD FIXTURE

- A. LED Broad Worklight, 90W shall have the following characteristics:
 1. Worklight fixture designed to create a radially symmetrical pattern of light
 2. 90W LED array
 3. Output of 5000 lumens, minimum
 4. Color temperature of 3500K, CRI of 90+
 5. LED "lamp life" of 40,000 hours
 6. Dimmable via mains voltage dimming
 7. The fixture housing shall be made of 18 gauge steel with a black baked enamel finish
 8. The lens shall be a diffused borosilicate safety lens mounted in a steel frame
 9. 36" power cable terminated with a male two pin and ground 20A stage pin connector
 10. C-Clamp for attachment of fixture to pipes of up to 3"
 11. Convection cooled for silent operation
 12. UL approved
 13. Provide accessories as defined in the appendix to this specification
 14. Provide in quantities defined in the appendix to this specification
 15. Provide Osram Kreios FLx 90W or approved equal

2.7 PROFILE LED WHITE SOURCE SPOTLIGHT RETROFIT

- A. Profile LED White Source Retrofit shall have the following characteristics:
 1. Profile spotlight lighting fixture utilizing ellipsoidal reflector design
 2. Burner assembly using an LED source providing a 3000K color temperature 90+ CRI white light
 3. Beam angle of 17 degrees
 4. Field angle of 25 degrees
 5. LED "lamp life" of 30,000 hours
 6. Power cable terminated with parallel blade U-ground Edison connector
 7. Input voltage of 114 to 125VAC at 60HZ
 8. Power consumption of 155W at full intensity
 9. Dimmable via DMX or a line-dimmed source
 10. DMX512 in and through via RJ45 connectors
 11. Die cast aluminum fixture construction
 12. Dichroic reflector
 13. Ability to adjust lens system to provide a flat or peaked light output
 14. Light output shall have no discernible chromatic aberration
 15. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat
 16. 4 independent framing shutters with 25 degree minimum rotation of shutter assembly with the fixture
 17. Slot for pattern holder or mechanical iris unit
 18. C-Clamp for attachment of fixture to pipes of up to 3"
 19. UL or ETL approved

20. Integral low noise fan controlled by on-board thermostat
21. Provide accessories as defined in the appendix to this specification
22. Provide in quantities defined in the appendix to this specification
23. Provide Electronic Theatre Controls, Source 4WRD (Gallery Version)

2.8 PROFILE LED COLOR MIXING SPOTLIGHT RETROFIT

1. Profile spotlight lighting fixture retrofit utilizing minimum of 60 LED array providing 7 colors
2. LED "lamp life" of 20,000 hours
3. Fixture form factor similar in size and shape to incandescent profile spotlights
4. Neutrik powerCON in and through receptacles
5. Power cable terminated with parallel blade U-ground Edison connector
6. Input voltage of 100 to 240VAC at 50/60HZ
7. 15-bit dimming engine
8. Fixture parameters controlled via DMX512
9. 15 control addresses
10. DMX512 in and through connectors
11. Die cast aluminum fixture construction
12. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat
13. Slot for pattern holder or mechanical iris unit
14. C-Clamp for attachment of fixture to pipes of up to 3"
15. UL or ETL approved
16. Integral low noise fan controlled by on-board thermostat
17. Provide accessories as defined in the appendix to this specification
18. Provide in quantities defined in the appendix to this specification
19. Provide Electronic Theatre Controls, Source Four LED Series 2 Light Engine only or approved equal

2.9 INCANDESCENT SOURCE PROFILE SPOTLIGHTS

- A. 19 Degree Profile Spotlight shall have the following characteristics:
 1. Profile spotlight lighting fixture utilizing ellipsoidal reflector design
 2. 575W HPL long life lamp
 3. Beam angle of 15 degrees
 4. Field angle of 18 degrees
 5. Lamp aligned axially within fixture's reflector
 6. Die cast aluminum fixture construction
 7. Dichroic reflector
 8. Ability to adjust lens system to provide a flat or peaked light output
 9. Light output shall have no discernible chromatic aberration
 10. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat
 11. 4 independent framing shutters with 25 degree minimum rotation of shutter assembly with the fixture
 12. Slot for pattern holder or mechanical iris unit
 13. 36" power cable terminated with a male two pin and ground 20A stage pin connector
 14. C-Clamp for attachment of fixture to pipes of up to 3"
 15. UL approved
 16. Provide accessories as defined in the appendix to this specification
 17. Provide in quantities defined in the appendix to this specification
 18. Provide Electronic Theatre Controls, Source Four 19 Degree or approved equal
- B. 26 Degree Profile Spotlight shall have the following characteristics:
 1. Profile spotlight lighting fixture utilizing ellipsoidal reflector design
 2. 575W HPL long life lamp
 3. Beam angle of 17 degrees
 4. Field angle of 25 degrees
 5. Lamp aligned axially within fixture's reflector

6. Die cast aluminum fixture construction
 7. Dichroic reflector
 8. Ability to adjust lens system to provide a flat or peaked light output
 9. Light output shall have no discernible chromatic aberration
 10. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat
 11. 4 independent framing shutters with 25 degree minimum rotation of shutter assembly with the fixture
 12. Slot for pattern holder or mechanical iris unit
 13. 36" power cable terminated with a male two pin and ground 20A stage pin connector
 14. C-Clamp for attachment of fixture to pipes of up to 3"
 15. UL approved
 16. Provide accessories as defined in the appendix to this specification
 17. Provide in quantities defined in the appendix to this specification
 18. Provide Electronic Theatre Controls, Source Four 26 Degree or approved equal
- C. 36 Degree Profile Spotlight shall have the following characteristics:
1. Profile spotlight lighting fixture utilizing ellipsoidal reflector design
 2. 575W HPL long life lamp
 3. Beam angle of 25 degrees
 4. Field angle of 35 degrees
 5. Lamp aligned axially within fixture's reflector
 6. Die cast aluminum fixture construction
 7. Dichroic reflector
 8. Ability to adjust lens system to provide a flat or peaked light output
 9. Light output shall have no discernible chromatic aberration
 10. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat
 11. 4 independent framing shutters with 25 degree minimum rotation of shutter assembly with the fixture
 12. Slot for pattern holder or mechanical iris unit
 13. 36" power cable terminated with a male two pin and ground 20A stage pin connector
 14. C-Clamp for attachment of fixture to pipes of up to 3"
 15. UL approved
 16. Provide accessories as defined in the appendix to this specification
 17. Provide in quantities defined in the appendix to this specification
 18. Provide Electronic Theatre Controls, Source Four 36 Degree or approved equal
- D. 50 Degree Profile Spotlight shall have the following characteristics:
1. Profile spotlight lighting fixture utilizing ellipsoidal reflector design
 2. 575W HPL long life lamp
 3. Beam angle of 33 degrees
 4. Field angle of 51 degrees
 5. Lamp aligned axially within fixture's reflector
 6. Die cast aluminum fixture construction
 7. Dichroic reflector
 8. Ability to adjust lens system to provide a flat or peaked light output
 9. Light output shall have no discernible chromatic aberration
 10. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat
 11. 4 independent framing shutters with 25 degree minimum rotation of shutter assembly with the fixture
 12. Slot for pattern holder or mechanical iris unit
 13. 36" power cable terminated with a male two pin and ground 20A stage pin connector
 14. C-Clamp for attachment of fixture to pipes of up to 3"
 15. UL approved
 16. Provide accessories as defined in the appendix to this specification
 17. Provide in quantities defined in the appendix to this specification

18. Provide Electronic Theatre Controls, Source Four 50 Degree or approved equal

2.10 INCANDESCENT SOURCE FIXED BEAM FIXTURES

- A. Parabolic Aluminized Reflector fixture, 575W with aluminum reflector shall have the following characteristics:
1. Fixed beam lighting fixture utilizing modified parabolic reflector design
 2. 575W HPL long life lamp
 3. Reflector shall be faceted and finished with polished aluminum
 4. Beam and field angles shall be variable with the use of interchangeable lenses
 5. Lenses shall be available in four beam spreads:
 - a. VNSP – 9 degree beam angle
 - b. NSP – 10 degree beam angle
 - c. MFL – 12/18 degree beam angle
 - d. WFL – 17/27 degree beam angle
 6. Lenses shall be changeable without the use of tools
 7. Die cast aluminum fixture construction
 8. All adjustments shall have reliable locking knobs that do not require the use of tools and do not transmit heat
 9. 36" power cable terminated with a male two pin and ground 20A stage pin connector
 10. C-Clamp for attachment of fixture to pipes of up to 3"
 11. UL approved
 12. Provide lenses as defined in the appendix to this specification
 13. Provide accessories as defined in the appendix to this specification
 14. Provide in quantities defined in the appendix to this specification
 15. Provide Electronic Theatre Controls, Source Four PAR EA or approved equal.

2.11 INCANDESCENT SOURCE BROAD FIXTURE

- A. Broad Worklight, 500W shall have the following characteristics:
1. Worklight fixture designed to create a radially symmetrical pattern of light
 2. 500W EHD lamp
 3. Reflector shall have a patterned specular finish
 4. The fixture housing shall be made of 18 gauge steel with a black baked enamel finish
 5. The lens shall be a clear borosilicate safety lens mounted in a steel frame
 6. The lens frame shall be mounted in a hinged front lamp access door with locking latch
 7. 36" power cable terminated with a male L5-20 twist-lock connector
 8. C-Clamp for attachment of fixture to pipes of up to 3"
 9. UL approved
 10. Provide accessories as defined in the appendix to this specification
 11. Provide in quantities defined in the appendix to this specification
 12. Provide Lighting & Electronics, Inc. Worklite Q or approved equal.

2.12 AUTOMATED FIXTURES

- A. LED Source Automated Framing Spotlight shall have the following characteristics:
1. Moving head spot lighting fixture designed utilizing a 3000K LED source
 2. 468W LED engine
 3. Internal dimmer / shutter control
 4. Minimum pan of 540 degrees
 5. Minimum tilt of 268 degrees
 6. Controllable field angle varying from 12 to 48 degrees
 7. Integral CMY color mixing system
 8. Five position rotating pattern wheel
 9. Strobe effect
 10. Neutrik powerCON TRUE1 receptacle
 11. Power cable terminated with parallel blade U-ground Edison connector
 12. Input voltage of 120 to 240VAC at 50/60Hz
 13. Operable in any orientation

14. Fixture parameters controlled via DMX512
 15. 38 control addresses
 16. DMX512 In and Through connectors
 17. 4 independent framing shutters with +/- 30° individual adjustment and +/-55° rotation of shutter assembly within the fixture
 18. Half-coupler clamp for attachment of fixture to pipes
 19. UL or ETL approved
 20. Integral low noise fan controlled by on-board thermostat
 21. Provide accessories as defined in the appendix to this specification
 22. Provide in quantities defined in the appendix to this specification
 23. Provide Martin MAC Encore Performance WRM or approved equal.
- B. LED Source Automated Wash Light shall have the following characteristics:
1. Moving head wash lighting fixture designed utilizing a 3000K LED source
 2. 750W LED engine
 3. Electronic dimming with a minimum of 4 dimming curve options
 4. Minimum pan of 540 degrees
 5. Minimum tilt of 270 degrees
 6. Controllable field angle varying from 11 to 53 degrees
 7. RGBW color mixing system
 8. Shutter effect
 9. Neutrik powerCON receptacle
 10. Power cable terminated with parallel blade U-ground Edison connector
 11. Input voltage of 120 to 240VAC at 50/60Hz
 12. Operable in any orientation
 13. Fixture parameters controlled via DMX512
 14. 33 control addresses
 15. DMX512 In and Through connectors
 16. Half-coupler clamp for attachment of fixture to pipes
 17. UL or ETL approved
 18. Integral low noise fan controlled by on-board thermostat
 19. Provide accessories as defined in the appendix to this specification
 20. Provide in quantities defined in the appendix to this specification
 21. Provide Martin MAC Quantum Wash or approved equal.
- C. Discharge Source Automated Framing Spotlight shall have the following characteristics:
1. Moving head spot lighting fixture designed utilizing an arc-discharge source
 2. 1000W short-arc discharge lamp
 3. Internal mechanical dimmer / shutter
 4. Minimum pan of 540 degrees
 5. Minimum tilt of 268 degrees
 6. Controllable field angle varying from 10 to 44 degrees
 7. Integral CMY color mixing system
 8. Five position rotating pattern wheel
 9. Strobe effect
 10. Neutrik powerCON receptacle
 11. Power cable terminated with twist-lock L6-20 connector
 12. Input voltage of 120 to 240VAC at 50/60Hz
 13. Operable in any orientation
 14. Fixture parameters controlled via DMX512
 15. 32/40 control addresses
 16. DMX512 In and Through connectors
 17. 4 independent framing shutters with +/- 30 degree individual adjustment and +/- 55 degree rotation of shutter assembly within the fixture
 18. Half-coupler clamp for attachment of fixture to pipes
 19. UL or ETL approved
 20. Integral low noise fan controlled by on-board thermostat
 21. Provide accessories as defined in the appendix to this specification

22. Provide in quantities defined in the appendix to this specification
23. Provide Martin MAC Viper Performance or approved equal.

2.13 FOLLOWSPOTS

- A. Metal Arc Source Followspot Medium Throw shall have the following characteristics:
 1. Followspot shall be designed specifically for manually following performers
 2. 1200W HMI lamp source
 3. Manual optical train with beam angle variable from 7 to 14.5 degrees
 4. Fully closing iris
 5. Seven-way self-cancelling color changer
 6. Integral low noise fan controlled by on-board thermostat
 7. Balanced pan and tilt operation
 8. One-handed operation for dim, pan and tilt control
 9. UL or ETL approved
 10. Twelve foot power cable terminated with parallel blade U-ground Edison connector
 11. Floor mount stand designed for use with this followspot
 12. Truss hanging hardware designed for use with this followspot
 13. Provide accessories as defined in the appendix to this specification
 14. Provide in quantities defined in the appendix to this specification
 15. Provide Robert Juliat Super Corrigan, or approved equal
- B. Metal Arc Source Followspot Long Throw shall have the following characteristics:
 1. Followspot shall be designed specifically for manually following performers
 2. 2500W HMI lamp source
 3. Manual optical train with beam angle variable from 3 to 8 degrees
 4. Quartz condenser lens
 5. Internal mechanical dimmer
 6. Fully closing iris
 7. Independent control of beam size and focus
 8. Six-way self-cancelling color changer with individually removable color frames
 9. Integral low noise fan
 10. Balanced pan and tilt operation
 11. One-handed operation for dim, pan and tilt control
 12. External power supply with hot restrike
 13. Input voltage of 208VAC at 60Hz
 14. UL or ETL approved
 15. Power cable terminated with twist-lock L6-20 connector
 16. Floor mount stand designed for use with this followspot
 17. Truss hanging hardware designed for use with this followspot
 18. Provide accessories as defined in the appendix to this specification
 19. Provide in quantities defined in the appendix to this specification
 20. Provide Robert Juliat Cyrano, or approved equal

2.14 ACCESSORIES

- A. Provide accessories as described in the attached Appendix.
- B. Each fixture to be supplied with:
 1. Color frames of appropriate size
 2. Power input cable
 3. Five foot data cable for all LED fixtures
 4. Clamp
 5. Safety cable

2.15 STAGE CABLE

- A. General

1. All stage extension cables shall be furnished with two 3" clear shrink wrap pieces, unshrunk, installed on cables for user labeling.
 2. One shrink wrap piece shall be shrunk over a band of color at either end of the cable that shall identify the length of the cable. Alternate: shrink wrap shall be integral color as indicated.
 3. Confirm color codes with Owner prior to fabrication.
- B. Jumper Cables
1. All shall be Extra Hard usage cable utilizing NEMA or Neutrik PowerCON plugs as shown in the Appendix. Provide two affixed black sash cord ties.
 2. Provide with 20A connectors and 12/3 SOW-A cable.
 3. Provide quantities as shown in Appendix.
- C. Two-fer Cables
1. All shall be 36" long, #12 AWG individual stranded cables in fiberglass sheaths or a 12/3 SO cord in a molded assembly with appropriate strain relief as approved.
 2. Provide with connectors as shown in Appendix.
 3. Provide quantities as shown in Appendix.
- D. Multi-cable Extensions
1. Provide multi-cable extensions built from 75°C Extra Hard Usage cords, which consist of specified number of circuits rated 20 Amp at 125 Volts in accordance with Article 520 of the National Electrical Code
 2. Multi-cable ends shall terminate in cylindrical male and female multi-pin connectors appropriately sized to mate with wiring devices as specified above.
 3. Strain Relief:
 - a. Provide Hubbell Kellems Heavy Duty, Single Eye, Closed Mesh strain relief on each multi-cable extension
 4. Provide quantities as shown in Appendix.
- E. Multi-cable "Fan-Out" Cables
1. Provide multi-pin to 20A connector "fan-out" cables of six 12/3 S or SO neoprene covered cables
 2. Heavy-duty, locking multi-pin connector with clamping cable glands strain relief to mate with, and be of the same manufacture as, the multi-cable plug boxes
 3. 20A connectors to be as listed in the Appendix
 4. Male multi-pin to 20A female connector fan-outs:
 - a. The cables shall be bundled to "fan-out" on 18" centers
 - b. The first connector drop shall be 2'-0" from the multi-pin connector
 - c. Connector drops shall be 18" long
 5. Each 20A circuit shall have a discrete ground wire terminating in the multi-pin connector. The grounds may be common within the multi-pin connector.
 6. Label connector drops with appropriate alphabetic circuit designations ("A" through "F") keeping circuiting sequence identical through all multi-cables. All labels shall be affixed to the connector drops with shrink wrap tube. The "A" connector drop shall be closest to the multi-pin connector.
 7. In addition to the alphabetic designations indicated above, securely attach blank white Plexiglas labels to 20A connectors. This surface shall allow the user to mark the circuit designation on the receptacle with china marker.
 8. Provide quantities as shown in Appendix.
- F. DMX Extension Cables
1. Provide DMX extension cables of ACT Tour-Plex Data-Sure or equal
 2. 5-pin XLR connectors to mate with DMX nodes.
 3. Provide quantities as shown in Appendix.
- G. DMX Terminators
1. Provide In-Line DMX Terminator with status LED for end of line termination
 2. Provide quantities as shown in Appendix.
- H. Ethernet Extension Cables

1. Provide Ethernet Extension Cables of ACT Tour-Plex Tour-Net Cat5e or equal
2. RJ45 connectors to mate with Ethernet Taps.
3. Provide quantities as shown in Appendix.

2.16 SOURCE QUALITY CONTROL

- A. All equipment and components shall be factory tested prior to shipping.

2.17 FABRICATION

- A. Fabricate all work in this section in accordance with the Architect and General Contractor'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.

PART 3 EXECUTION

3.1 CONTRACTORS

- A. The equipment described herein shall be provided by a single Theatrical Lighting Fixtures and Accessories Contractor who will be responsible for furnishing all services described herein, including but not limited to coordination and supervision of the engineering, submittals and provision for all equipment specified herein.
- B. Contractor shall provide the Warranty and Maintenance services specified herein.
- C. To establish comparative standards of quality, the provision of the 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

LVH Entertainment Systems
1801 Highland Avenue,
Unit E
Duarte, CA 91010
Tel: (805) 278-4584

Texas Scenic Co.
8053 Potranco Road
San Antonio, TX 78251
Tel: 210-684-0091

- D. 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.

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. Provide site labor to unpack fixtures, install lamps, attach hanging clamps, and move equipment to storage area at General Contractor's direction.

3.4 ADJUSTING

- A. Adjust all equipment and components for operation in accordance with the specifications, approved shop drawings, submittals and pertinent project drawings prior to the demonstration indicated herein.

3.5 CLEANING

- A. Touch-up minor abrasions and imperfections created during installation to match original finish as required.
- B. Remove paint spatters, other spots, dirt and debris.
- C. Remove from the premises all debris caused by this work. All unnecessary equipment and materials, including packing 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. Installed equipment to be operated for approval and inspected for quality by the Architect and the Owner.
 - 2. Adjustments or modifications shall be made as directed by the Architect and the Theatre Consultant.
 - 3. Cost of re-inspection and additional testing by the Architect, Owner or 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, the Owner's designated staff or representatives shall be instructed in the use, care and maintenance of all items.
2. Instruction must be by qualified expert operators who have actual experience with equipment in performance conditions.
3. Instruction to be scheduled in conformance with project construction schedules 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 quantities and accessories.

END OF SECTION

SECTION 122413 ROLLER WINDOW SHADES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manual roller shades (WT-__) & (WT-__).
 - 2. Manual double roller shades (WT-__)
 - 3. Motorized Roller Shades (WT-__)
 - 4. Motorized double roller shades (WT-__).

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:
 - 1. Flame-Resistance Ratings: Passes NFPA 701.

- 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.,
 4. Lutron Electronics Co., Inc.,
 5. Nysan Solar Control Inc.
 6. Silent Gliss USA, Inc.

2.2 MANUALLY-OPERATED ROLLER SHADES

- A. (WT-1) Manually-Operated Roller Shade: Manual roller shades, with fascia, continuous stainless-steel bead-chain operator and related heavy duty mounting systems and accessories.
 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

- A. (WT-2) Motor-Operated Visually-Transparent Shade: Motor-operated roller shades and related heavy duty mounting systems and accessories.
 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. ___ by Draper, Inc..
 - b. 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.
 - a. Blackout Single-Fabric Shade with Opaque Acrylic Backing: ThermoVeil Equinox 0100 Series by MechoShade Systems, Inc..
 - 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. Visually-Transparent Shade Fabric: Refer to Material Identification List.
 - 3. Blackout Shade Fabric: Refer to Material Identification List.

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.
 - 2. Motor Characteristics: Single phase, [24] [110] [220] V, 60 Hz.
 - 3. Motor Mounting: Within manufacturer's standard roller enclosure.
- 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

SECTION 123551 MUSIC EDUCATION STORAGE CASEWORK

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.
 1. Basis of Design: Wenger Corporation, Owatonna, MN; 800-493-6437; www.wengercorp.com.
- 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.
 3. Panel Doors: Particleboard thermoset panel, 3/4 inch thick, inset-type.
 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.
 1. Basis of Design: Wenger Corporation, Owatonna, MN; 800-493-6437; www.wengercorp.com.
- 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.
 3. Exposed End Cover Panels: Particleboard thermoset panel, 3/4 inch thick.
 4. Casters: 4 rigid 8 inch diameter casters.
 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:
1. Sheet Metal Screws: SAE J78, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
 2. Wood Screws: ASME B18.6.1.
 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 124800 ENTRANCE FLOOR MATS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Vestibule carpet tile (FL MAT-1).
- B. Related Sections:
 - 1. Section 033000 - Cast-in-Place Concrete: Coordinate size and location of recesses in concrete with installation of finish floors to receive floor mats.

1.2 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples: For each type of product indicated, full tile size.
- C. Maintenance Data: For floor mats to include in maintenance manuals.

1.3 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.

1.4 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. Entrance Tiles: Full-size units equal to 2 percent of amount installed for each size, color, and pattern indicated, but no fewer than 10 units.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Accessibility Requirements: Provide installed floor mats that comply with Section 4.5 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and Sections 302 and 303 in CC A117.1.

2.2 ENTRANCE MATS

- A. (FL MAT-1) Carpet-Type Tiles: Polyester carpet bonded to 1/8- to 1/4-inch- thick, flexible vinyl backing to form mats 3/8 or 7/16 inch thick with nonraveling edges.
 - 1. Basis of Design: As indicated on Material Identification List.

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. Adhesive and Sealant VOC Limits: According to South Coast Air Quality Management District Rule 1168 and GS-36 for aerosols. VOC Limits: As tested using U.S. EPA Reference Test Method 24 and as defined by South Coast Air Quality Management District Rules: SCAQMD Rule 1168, Adhesive and Sealant Applications.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Preparation: Comply with CRI's "CRI Carpet Installation Standard" and with carpet manufacturer's written installation instructions for preparing substrates.
- B. 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.
 - 1. 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. Installation: 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.
- D. 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.
 - 3. Vacuum carpet using commercial machine with face-beater element.
- E. Protection: Protect installed carpet to comply with CRI's "CRI Carpet Installation Standard."

END OF SECTION

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. 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
 - g. 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 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.
 - a. International Building Code 2012
 - 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 1/4" scale layout plan(s) clearly indicating seat widths, dimensions for coordination for seat mounting, aisle widths and row-to-row clearances.
 6. Provide 1/2" 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

Figueras Seating Americas
1860 Polk Street
Hollywood, FL 33020
Tel: (786) 331-9433

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) TBD
 - (b) TBD
 - 2) Wood back panel with hardwood edges, White Oak veneer
 - 3) Upholstered seat with wood bottom, White Oak veneer
 - 4) Wood aisle end panel, White Oak veneer
 - 5) Solid wood arm rests, stain TBD by Architect
 - 6) Concealed low voltage LED end panel lights
 - 7) Fabric: Level 'XX' fabric, pattern and color TBD by Architect.
 - b. Valade Jazz Center
 - 1) Basis of design appearance:
 - (a) TBD
 - (b) TBD
 - 2) Wood back panel with hardwood edges, White Oak veneer
 - 3) Upholstered seat with wood bottom, White Oak veneer
 - 4) Wood aisle end panel, White Oak veneer
 - 5) Solid wood arm rests, stain TBD by Architect
 - 6) Concealed low voltage LED end panel lights
 - 7) Fabric: Level 'XX' fabric, pattern and color TBD by Architect.

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

1. Flame Retardant performance: Upholstery components and the assembly thereof shall be in conformance with flammability standards as set forth in California Technical Bulletin #117.
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:

1. Gray Iron Castings: American Society of Testing Materials A48, Class 25.
2. Steel Plates, Shapes, and Bars: American Society of Testing Materials A36.
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.
5. Concealed Plywood: PS 1/ANSI A199.

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 to be selected by the Architect from one of the manufacturer's standard seating fabrics.
 - b. Fabric color shall selected by the Architect from one of the manufacturer's standard colors offered within the specified grade.
 - c. Flame Retardant: Meets Class "A" flamespread rating in accordance with American Society of Testing Materials-E84, NFPA #255, UBC #42-1, and Underwriters Laboratory #723.
 - d. Light Fast: Exceeds 48 hour NAFM requirement. Test method A.A.T.C.C.-16A.
 - e. 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.
- 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 seating units for attachment to floor conditions, both sloped and level, as indicated, using standards which have been manufactured to allow maximum cleaning space below point of attachment while maintaining seat height at proper elevation to 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 DONOR PLATES

- A. Donor plates shall be 7/8" wide x 3" long, brushed bronze or aluminum.
- B. Fixing shall be by two-part epoxy adhesive.
- C. Donor plates shall be accommodated for all chairs and shall be located in a recess for flush mounting in all armrests near the rear of the armrest.
- D. Donor 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.

2.14 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.

2.15 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.

END OF SECTION

SECTION 126100 FIXED AUDIENCE SEATING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standard-mounted, fully-upholstered chairs with hardwood-veneer shells and end panels, and upholstered inserts.

1.2 COORDINATION

- A. Coordinate layout and installation of electrical wiring and devices with seating layout to ensure that floor junction boxes for electrical devices are accurately located to allow connection without exposed conduit.
- B. Coordinate layout and installation of diffuser pedestals with HVAC work and with properties of diffuser pedestals to ensure alignment, proper air diffusion, and correct seat locations.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of components, and finishes for fixed audience seating.
1. Include electrical characteristics of electrical components, devices, and accessories.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Seating Layout: Show seating layout, aisle widths, row-lettering and chair-numbering scheme, chair widths, and chair spacing in each row.
 2. Accessories: Show accessories, including locations of left- and right-hand tablet arms, electrical devices, accessibility provisions, and attachments to other work.
 3. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples: For each type of exposed finish required, prepared on Samples of size indicated below:
1. Baked-on Coating Finishes: Manufacturer's standard-size unit, not less than 3 inches square.
 2. Wood and Plywood Materials and Finishes: Manufacturer's standard-size unit, not less than 3 inches square.
 3. Upholstery Fabric: Full width by 36-inch-long section of fabric from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of fabric.
 4. Row-Letter and Chair-Number Plates: Full-size units with letters and numbers marked.
 5. Aisle Lighting: Full-size unit.
 6. Exposed Fasteners: Full-size units of each type.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of fixed audience seating.
- B. Material Certificates: For each type of flame-retardant treatment of fabric.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fixed audience seating to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS (ATTIC STOCK)

- A. Furnish extra materials from the same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Chair Seats: 2 percent of quantity installed.
 2. Seat Covers: 3 percent of quantity installed.

3. Chair Backs: 2 percent of quantity installed.
4. Back Covers: 2 percent of quantity installed.
5. Armrests: 2 percent of quantity installed.
6. Aisle Armrests: 2 percent of quantity installed.
7. Tablet Arms: 5 percent of quantity installed.
8. Chair Seat Hinges: 5 percent of quantity installed.
9. Fabric: 2 percent of quantity installed, and additional 36 yards for use with loose seats (provided by others).

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of seating required, including accessories and mounting components, from single source from single manufacturer.
 1. Upholstery Fabric: Obtain fabric of a single dye lot for each color and pattern of fabric required.
- B. 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 mockups for the following types of fixed audience seating including fabric, finishes, and accessories:
 - a. Double-seat mock-up with (1) aisle light.
 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.
- C. Preinstallation Conference: Conduct conference at Project site.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install seating until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary or permanent HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Verify actual dimensions of seating layout and construction contiguous with seating by field measurements before fabrication.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fixed audience seating that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including standards, beams, and pedestals.
 - b. Faulty operation of self-rising seat mechanism.
 - c. Faulty operation of electrical components.
 - d. Faulty operation of tablet arm or structural failure of tablet arm.
 - e. Wear and deterioration of fabric and stitching beyond normal use.
 - f. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 2. Warranty Periods: As follows, from date of Substantial Completion.
 - a. Structural: Ten (10) years.
 - b. Seat Lift Operating Mechanism: Lifetime.
 - c. Electrical Components: One (1) year.
 - d. Plastic, Wood, and Paint Components: Five (5) years.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics of Upholstered Chairs:

1. Fabric: Class 1 according to DOC CS 191-1953 or 16 CFR 1610, tested according to California Technical Bulletin 117.
 2. Padding: Comply with California Technical Bulletin 117.
 3. Full-Scale Fire Test: Comply with California Technical Bulletin 133.
- B. Strength and Durability Performance: Chairs and components shall pass testing according to BIFMA X5.4.
- 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.

2.2 AUDIENCE FIXED SEATING

- A. Audience Fixed Seating: Interior assembly-space seating in permanent arrangement, as shown on Drawings.
1. Fabric Upholstered Chairs:
 - a. Rear Panel: Hardwood-veneer plywood, concealed fasteners.
 - b. Self-Rising Seat Mechanism.
 2. Chair Mounting Standards: Floor-mounted standards, type as indicated by model selection.
 3. End Panels: Hardwood-veneer plywood.
 4. Armrests: Hardwood, concealed mounting.
 5. Aisle Lighting Fixtures: Manufacturer's standard LED fixtures.
 6. Row-Letter and Chair-Number and Donor Plates: As selected by Architect from Manufacturer's standard types, with black embossed characters, mechanically-fastened.
 7. Accessible Seating: Provide removable chairs where wheelchair spaces are indicated.
- B. Products and Manufacturers:
1. IDEA Model WB-CS; by Series Seating.
 2. VIA Model WB-CS; by Series Seating.
 3. Century PAC, Model No. 6b.12seq.17bf.4; by Irwin Seating.
 4. Series 200; by Wenger Corporation.
 5. Hussey Quattro Chair System, Designer Model No. S5AS3H3APAFOW; by Hussey Seating Company.
 6. Concerto by KI.
 7. Aria by KI.

2.3 FIXED AUDIENCE SEATING

- A. Source Limitations: Obtain each type of seating required, including accessories and mounting components, from single source from single manufacturer.
1. Upholstery Fabric: Obtain fabric of a single dye lot for each color and pattern of fabric required.
- B. *Floor-Mounted, Two-Part, Fabric-Upholstered Chairs with Wood Seats, Back Panels, Armrests, and End Panels:*
1. *Basis-of-Design: Madison 2013-BW Reveal by Series Seating.*
 2. *Other Product: Symphony by Ducharme Seating International Inc..*
 - a. *Seat: Fully upholstered with wood panel.*
 - b. *Back: Upholstered with wood veneer panel.*
 - c. *Armrest: flat top with rounded edges. Arm to extend to front side of seat back.*
 3. *Other Product: Customized Allegro PAC Chair by Irwin Seating Company.*
 - a. *Seat: 12s Ergo Seat.*
 - b. *Model Number: 27hbsp.12se.14ex-bf.4 .*
- C. Accessible Seating: Where shown on theatrical seating plans, provide ADA transfer arms, arranged to swing rearward, creating sideways access to the chair. Aisle standards so equipped shall be provided with a label displaying an easily recognizable "handicapped" symbol.

2.4 MATERIALS AND COMPONENTS

- A. Hardwood Lumber and Veneer Faces:
1. Wood Species: Manufacturer's standard.

2. Wood Grain, Stain and Finish: Matching Architect's sample for WD-1, in accordance with Section 064000 - Architectural Woodwork.
 - a. Exposed wood shall be sanded smooth and stained to color selected with low-VOC water-based stain and top coat to provide with a high quality finish.
 3. Exposed Plywood: HPVA HP-1, Face Grade A, hardwood veneer core with color-matched hardwood-veneer faces, made with adhesive containing no urea formaldehyde.
- B. Upholstery Fabric:
1. Basis of Design: FABRIC-3, as indicated on Material Identification List.
 2. Provide extra material in accordance with Part 1 of this specification.
 3. Fire-Test-Response Characteristics: Class 1 according to DOC CS 191 and 16 CFR 1610.61, tested according to California Technical Bulletin 117.
 - a. ASTM E 84: Pass.
 - b. NFPA 255: Pass.
 - c. NFPA 701: Pass.
- C. Upholstery Padding: Flexible, cellular, cold-molded foam, in compliance with California Technical Bulletin 117.
- D. Metal Components:
1. Electrostatic epoxy-polyester oven baked powder coating.
 2. Thickness: 3mm.
 3. Color: Black, semi-luster.
 4. Grid adherence: 100%.
- E. Backs: Fixed height, pitched, upholstered backs.
1. Rear Panel: Manufacturer's 'Designer' panel
 - a. The rear of the back shall be 9/16", 7-ply, high-frequency glued, engineered hardwood with a wood veneer face surface and veneer edges. The back panel to be attached to inner panel by no less than 4 concealed fasteners to inner panel.
 2. Top Corners: 1/8-inch radius.
 3. Edge Reveal: 1-1/2-inch
 4. Back Height: Standard-style backs, 35 inches high.
 5. Back Pitch: Fixed, at varying angles. See Drawings for layout of units with varying back pitch.
 6. Padding Thickness: 2 inches.
 7. Assembly: Back to connect to steel frame structure by means of concealed fasteners.
- F. Seats: Self-rising upholstered seats.
1. Seat Foundation: 7/8" diameter 11-gauge tubular steel frame and 1" x 1/2" solid steel counter-weight plates with flexible support webbing.
 2. Seats shall be fully encapsulated in cold-cured sculptured molded foam.
 - a. Foam cushioning shall be minimum 3.4 lbs per square inch.
 - b. Overall Seat Thickness: nominal 4 3/4"
 3. Chair Seat Hinges: Self-lubricating, compensating type with noiseless self-rising seat mechanism passing ASTM F 851 and with positive internal stops cushioned with rubber or neoprene.
 4. Self-Rising Seat Mechanism: Counter-balanced gravity-lift
 5. Chair-Number Plates: Manufacturer's standard aluminum with black embossed characters.
 - a. Attachment: Manufacturer's standard method.
 - b. Provide ADA signage.
- G. Standards for Floor-Mounted Chairs: One-piece heavy-tube or reinforced steel sheet with welded mounting plate and welded connections for seat pivots, backs, armrests, and end panels. Standards to have wood veneer finish to match end panels.
1. Steel: ASTM A 36 plates, shapes, and bars; ASTM A 513 mechanical tubing; ASTM A 1008 cold-rolled sheet; and ASTM A 1011 hot-rolled sheet and strip.
 2. Metal Finish: Finish exposed metal parts with manufacturer's standard minimum 2-mil- thick, baked-on powder coating.
 - a. Color: As selected by Architect from manufacturer's full range.
 3. Wood Veneer Finish: As specified above.

- H. Armrests: Flat hardwood with 1/8" radiused edges, concealed mounting. Integral to end panel and matching intermediate standards.
- I. Tablet Arms: Manufacturer's standard-size foldaway tablet arm with plastic-laminate writing surface over medium-density fiberboard or plywood core and with rounded, matching PVC edges.
 - 1. Provide at all seats in Recital.
 - 2. Mounting: Right-hand mounted unless otherwise indicated.
 - 3. Fold-Away Mechanism: Cast-iron or steel hinge and swivel mechanism that give positive support in open position and semiautomatic return to stored position below arm block and parallel to chair.
- J. End Panels: Hardwood-veneer plywood with MDF core rectangular panel to floor, 2-inches thick, with square corners.
 - 1. MDF Core: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde
 - 2. Row-Letter Plates: Manufacturer's standard aluminum with black embossed characters.
 - a. Attachment: Manufacturer's standard method.
 - b. Provide ADA signage.
- K. Aisle Lighting Fixtures: Manufacturer's standard concealed LED aisle lighting at every chair on an aisle.
 - 1. LED's: Color temperature of 2700K.
 - 2. Power: 12 V.
 - 3. For low-voltage lighting, provide manufacturer's voltage-reduction device housed in safety enclosure equipped with fuses, terminal blocks, and safety disconnect.
 - 4. 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.
 - 5. Refer to electrical drawings for additional information.

2.5 FABRICATION

- A. Floor Attachments: Fabricate to conform to floor slope, if any, so that standards and pedestals are plumb and chairs are maintained at same angular relationship to vertical throughout Project, unless noted otherwise.
- B. Upholstery: Fabricate fabric-covered cushions with molded padding beneath fabric and with fabric covering free of welts, creases, stretch lines, and wrinkles. For each upholstered component, install pile and pattern run in a consistent direction.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine floors, risers, and other adjacent work and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Examine locations of HVAC supply ducts.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install seating in locations indicated and fastened securely to substrates according to manufacturer's written installation instructions.
 - 1. Use installation methods and fasteners that produce fixed audience seating assemblies with individual chairs capable of supporting an evenly distributed 600-lb static load without failure or other conditions that might impair the chair's usefulness.
 - 2. Install standards and pedestals plumb.
- B. Install seating with chair end standards aligned from first to last row and with backs and seats varied in width and/or spacing to optimize sightlines.

- C. Install riser-mounted attachments to maintain uniform chair heights above floor.
- D. Install chairs in curved rows at a smooth radius.
- E. Install seating so moving components operate smoothly and quietly.
- F. Install wiring conductors and cables concealed in components of seating and accessible for servicing.

3.3 INSTALLED WORK

- A. Adjusting:
 - 1. Adjust chair backs so that they are at proper angles and aligned with each other in uniform rows.
 - 2. Adjust hardware and moving parts to function smoothly so they operate easily. Lubricate bearings and sliding parts as recommended in writing by manufacturer.
 - 3. Adjust self-rising seat mechanisms so seats in each row are aligned when in upright position.
- B. Repair and Replacement:
 - 1. Repair minor abrasions and imperfections in finishes with coating that matches factory-applied finish.
 - 2. Replace damaged and malfunctioning components that cannot be acceptably repaired.
 - 3. Replace upholstery fabric damaged during installation or work of other trades.

END OF SECTION

SECTION 126600 RETRACTABLE BLEACHER SYSTEM AND SEATING

PART 1 GENERAL

1.1 SUMMARY

- A. The work in this section includes Retractable Bleacher System and Seating within the following spaces:
 - 1. Studio Theatre
- B. Section Includes:
 - 1. Major Systems and Equipment: furnish and install the following major elements and associated accessories:
 - a. Telescoping seating system
 - 1) Floor mounted fold down seating
 - 2) Movable floor mounted seating
 - 3) Guard rails
 - 4) Side closure panels
 - 5) Intermediate steps
 - 6) Aisle lighting
 - b. Fabric storage cover
 - 2. Work Results:
 - a. The equipment installed as a part of this Section shall result in a complete and working and code compliant retractable 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 Contract 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. 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
 - 1) 012300 - Alternates
 - b. Division 03 – Concrete
 - c. Division 04 – Masonry
 - d. Division 05 – Metals
 - e. Division 09 – Finishes
 - f. Division 11 – Equipment
 - 1) Section 116123 – Theatrical Platforming
 - 2) Section 116143 – Theatrical Draperies
 - 3) Section 116163 – Theatrical Lighting Systems Dimming and Control
 - g. Division 12 – Furnishings
 - 1) Section 127100 – Portable Seating
 - h. 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.
- B. Alternates
 1. Provide separate price information for material and labor associated with the following equipment and systems:
 - a. <<TBD>>
 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. <<TBD>>

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 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 for 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. Refer to 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. International Building Code 2012
 - 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. Installation of associated electrical work (see Electrical Drawings)
 - b. Completion of application of all interior wall and floor finishes.

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. 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.
- 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 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 ¼" = 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.
5. Provide ½" scale details showing relationship of seat rows, indicating seat back to back spacing and clear aisle accessway.
6. Provide complete, fully dimensioned, large scale detailed fabrication drawings of all major components.
7. Provide plan of row letter and seat number layout.
8. Provide requisite schematics, plans and sections indicating assembly and installation of components.
9. Provide indications by arrow and boxed caption of all variations from contract drawings and specifications, except where variation is indicated as acceptable.
10. Indicate all elements with appropriate safety factors and/or safety equipment.
11. Indicate recommended load limits for each element in the system with loading requirements.
12. Indicate Safe Working Load for each element in the system with loading requirements.
13. All elements shall be engineered, approved and drawings stamped by a Professional Engineer licensed in the project jurisdiction. The engineer shall verify that the equipment supplied under this section meets or exceeds the design criteria of this specification.
14. 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.
15. Provide a full Bill of Materials to be supplied, including quantities, manufacturer's part number, reference to applicable drawings, etc.

K. 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 indicated within 30 calendar days of contract award. 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. 30-inch square "quality" sample of platform carpeting.
 - b. 30-inch square "quality" sample of seat fabrics.
 - c. Manufacturer's color charts or actual samples of electrostatically applied powder finishes to be used on exposed parts.
 - d. Wood stain and other color choice samples as listed herein.
3. Additional samples must be submitted within 14 days of Architect's written request.

L. 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. Complete seat back and bottom in a quantity equal to five percent (5%) of each type of chair provided, with material prorated to sizes of chairs used.
 - b. Seat and back fabric or fabric covers in a quantity equal to five percent (5%) of each type of chair provided, with covers prorated to sizes of chairs used.
 - c. Spare aisle lighting assemblies for 25% of aisle lights installed.
 - d. Touch-up paint for all exposed metal surfaces.

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 telescopic seating systems for the theatre, 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 telescopic seating systems for no less than five years.
 4. 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, shall maintain thorough test and inspection procedures to assure uniform high quality of all raw materials used as well as the finished product.

5. 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.
6. 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.
7. The Contractor shall verify all system design loads.
8. 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.

C. 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 one seating tier assembly showing all specified components, including end closures and fascias. Unit shall be mounted to a carpeted deck as specified herein, with specified nosings, fascias, steps, aisle lights and railings.
 - b. The mock-up shall be of 2 chairs including selected fabric, finishes, etc. The mock-up should include the extreme widths of chairs to be provided. Both chairs in the mock-up shall include fully functional locking mechanism.
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.
 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 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. 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. 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 14 days of any item found defective during a period of one (1) year following the date of final acceptance. Ordinary wear and damage 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.

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:

Jezet Seating Ltd.
Siberiëstraat 10
3900 Overpelt
Belgium

Jezet Seating - US Contact
802 Berwick Crescent
Town of Mount Royal, QC H3R 2K9
Canada
Tel: +1-514-518-8701

- 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 system components listed below and as shown on the TS-series drawings:
1. Studio Theatre
 - a. A single retractable seating unit with fold-down chairs shall be provided, as shown on the drawings.
 - b. Movable seats in groups of 2 or 3 with self-rising seat pans shall be provided for use on the top row of the seating unit, as shown on the drawings.
 - c. Unit shall store under architectural room elements as shown on drawings.
 - d. The stored depth of the complete riser unit, with seats, shall not exceed 60" under any circumstances.

- e. Provide wood fascia panels permanently mounted to the front of the seating risers to provide a finished architectural face when the unit is stored.
- 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 seating unit to maximize vertical sightlines. End of rows shall align as indicated on the Drawings.
 4. In rows that 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. Retractable Bleacher System:
1. Each individual assembly shall be designed to support and resist, in addition to its own weight, the following forces:
 - a. Seats and decking shall be designed to resist a live load of 120 lbs. per linear foot.
 - b. 100 lbs. per square foot of live load.
 - c. Side sway load of 24 lbs. per linear foot of row.
 - d. Front to rear sway load of 10 lbs. per linear foot of row.
 2. Railings shall be designed to withstand the following horizontal forces applied separately:
 - a. 50 lbs. per foot acting outward at top rail.
 - b. 25 lbs. per foot acting outward at mid-rail.
 3. American Institute of Steel Construction (AISC), and Aluminum Association (AA) design criteria shall be the basis for all calculation of member sizes and connections.
 4. Wood members shall be designed in accordance with National Forest Products Association's National Design Specification for Wood Construction.
 5. All drive components shall be designed with a safety factor of 3x.
- B. Seating:
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.
- C. Fire Performance Characteristics:
- 1. Flame Retardant performance: Upholstery components and the assembly thereof shall be in conformance with flammability standards as set forth in California Technical Bulletin #117.
 - 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 I.

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 labels.

B. Materials shall conform to the following minimum standard specifications:

- 1. Gray Iron Castings: ASTM A48, Class 25.
- 2. Steel Plates, Shapes, and Bars: ASTM A36.
- 3. Steel Sheets for Baked Enamel Finish: ASTM 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.
- 5. Concealed Plywood: PS 1/ANSI A199.

C. 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.

D. Finishes

- 1. Finish for all exposed metal parts shall be selected from the manufacturer's standard color line to be chosen by the Architect.
- 2. Finish for all exposed plastic parts shall be selected from the manufacturer's standard color line to be chosen by the Architect.
- 3. Exposed wood (including plywood): Manufacturer's standard hardwood, free of visible defects. Color shall be stain per Architect. Species shall be as specified. Seal with lacquer.
- 4. Fabric:
 - a. Upholstery fabric to be selected from the manufacturer's standard line to be chosen by the Architect.
 - b. Fabric color to be selected from the manufacturer's standard color line to be chosen by the Architect.
 - c. Flame Retardant: Meets Class "A" flamespread rating in accordance with American Society of Testing Materials-E84, NFPA #255, UBC #42-1, and Underwriters Laboratory #723.
 - d. Light Fast: Exceeds 48 hour NAFM requirement. Test method A.A.T.C.C.-16A
- 5. Carpet shall be selected from the manufacturer's standard color line to be chosen by the Architect.
- 6. Cushions: Seat and back cushions made of open cell polyurethane foam.

2.5 RETRACTABLE BLEACHER SYSTEM

A. General

1. Retractable bleacher system shall be multiple tiered seating rows comprised of folding seat and deck components, risers, railings and supportive understructure.
2. Seating platforms shall operate on the telescopic principle, stacking vertically in minimum depth floor area when not in use.
3. Telescopic riser system shall be designed to allow the use of any quantity of leading rows separately without the full extension of the system.
 - a. Structural integrity of the system shall not be compromised when partially deployed.
 - b. Seats shall fully deploy with full range seat/back raise and lower without requiring any portion of an unused row to be deployed.
4. Chair systems: Fixed chairs shall be individually mounted on a folding stanchion on the telescoping riser platforms; multiple chairs supported on a single beam shall not be acceptable.
5. When seat backs are folded down in their storage mode, the uppermost portion of the seat back shall store within the height constraints of the treads.
6. Guard rails shall be permanently attached to riser unit and shall fold down for storage. Railings and their interface with decking shall be vertical and plumb with one another in each successive platform level.
7. Telescopic step units shall incorporate nose mounted integrated low voltage aisle lights at each platform level. System shall include individual switch contacts to allow illumination of aisle lights in deployed rows only.

B. Telescopic Platform Risers

1. The structure shall be made of welded rectangular steel tubes.
2. Transversal stiffness shall be ensured by (2) 1½" x 1¼" x ⅛" (40mm x 30mm x 3mm) steel tubes on both sides of each platform and an additional 1½" x 1¼" x ⅛" (40mm x 20mm x 3mm) tube. Each tube shall be minimum 18" (500mm) in length.
3. All welds shall be made at the factory by welders that are certified on the equipment and process used.
4. Moving rows shall be guided by horizontal roller bearings, fixed underneath the platform.
5. Decking and deck supports form rigid closed deck structure providing positive containment. Deck structure shall be fabricated leaving no opening such that any major human extremity or other items could pass either accidentally or deliberately.
6. Decking: Shall be fabricated from 11/16" nominal plywood with exterior glue, 5 ply, all plies Group 1 plugged crossband under face, produced in conformance with PS-1-74 of the National Bureau of Standards. Decking shall be through bolted to deck stiffeners, doublers, and frame cantilevers for structural integrity, including transmittance of sway forces to the understructure. Cover decking with carpet.
7. Fasteners: All structural connections that are not welded shall be made with S.A.E. stress rated bolts and self-locking nuts.
8. Steel structure shall be coated with an anti-corrosive polyester powder coating.
9. The nose of the platforms shall be equipped with a 1" x 1" x 1/16" (26mm x 26mm x 2mm) slip resistant anodized aluminum edging. Color to match carpet.

C. Automatic Platform Securing System

1. The platforms shall automatically lock upon opening and unlock upon closing.
2. At the rear of each platform, a spring operated 13/16" diameter steel shaft shall automatically interlock into a receptacle in the platform above it.
3. Upon retraction, each platform shall automatically cause the shaft to disengage.

D. Guiding System and Supports

1. The supports of each platform shall be composed of 100mm x 40mm x 4mm vertical columns/tubes welded to the lower guide section.
2. The support tubes shall be bolted to an adjustable upper shaft to allow the platforms to be adjusted during installation.
3. Between the vertical columns and the platforms, sway braces of 40mm x 40mm x 2mm steel tube shall be bolted to ensure lateral stability.
4. All parts shall be finished with an anti-corrosive polyester powder coating.

5. The lower guide sections shall have (4) 140mm x 44mm (5-1/2" x 1-3/4") polyurethane wheels, equipped with roller bearings.

E. Aisle Steps

1. Aisle steps shall be made by fitting intermediate steps on the platforms. Step height shall be one half the rise from one platform to the next.
2. Tread depths shall be uniform throughout the run of the aisle stair and shall comply with all applicable national, state and local codes.
3. Steps shall have a locking mechanism to securely attach them to the platforms without tools.
4. The same carpet that covers the platforms shall cover the steps and shall be bound at all edges using an anodized extrusion or angle, with non-slip surface and recessed fasteners.
5. All step edges shall have a 1" x 1" x 1/16" (26mm x 26mm x 2mm) anodized aluminum anti-slip edging with integrated LED step light.

F. Guard Rails

1. All guard rails shall comply with all applicable national, state and local codes with respect to dimension, graspable rail diameter, height, etc.
2. Provide graspable handrail at each aisle.
3. Side guard rails shall be permanently affixed to the platforms with a hinged base allowing them to "self store", folding inward over the seating.
4. Storage of the railings shall not impede the telescopic action and storage of the entire seating system.
5. Guard rails shall be positively latching, using a system similar to the latching/release devices used to secure the chair stanchions.
6. Color as listed below, per Architect. Sample to be approved by Architect before fabrication:
 - a. Studio Theatre: Per Architect

G. Side Closure

1. The open end of the structure facing the egress path in and out of the performance space shall be provided with a removable velour fabric closure system.
 - a. Velour shall be inherently flameproof and shall be a polyester-based woven product.
 - b. Mounting of the velour side closure shall rely on a Velcro fastening system with contact points at the platform structure and matching adhesion points sewn tight to the fabric hem.
 - c. All edges of the side closure shall be hemmed with a 4" minimum hem with interfacing to provide additional support and wear resistance.
2. Color as listed below, per Architect. Sample to be approved by Architect before fabrication:
 - a. Studio Theatre: Black

H. Wall Fastening System

1. Telescopic seating system shall be fastened to the rear wall by a folding or sliding steel channel and metal clamp lag bolted to the wall by 2 lag bolts and an adjustable clamp attached to the supports of the last platform of the retractable seating system.
 - a. Studio Theatre: Clamp system may be installed at floor or at top level of storage area.
2. Unit shall be designed to allow the full platform to move out from the wall.
3. Clamps will be attached with a pin to allow the retractable seating system to begin the deployment of the leading rows and move away from the wall the fixed distance shown in the drawings to deploy the last row.
4. Coordinate all required rear wall backing with the General Contractor.

I. Cable Management System

1. Motor drive control/power and aisle light power for telescopic seating system shall managed by a cable festoon system utilizing a C-track and 3" cable trolley.
 - a. 14 gauge steel C-track
 - b. Steel trolleys with 4 shielded ball bearing wheels
2. Mount to underside of gallery/storage area.
 - a. Verify construction and tolerances in the field
 - b. Maintain clear head height, where required, as indicated on the drawings
3. Unit shall be designed to allow the full platform to move out from the wall.

J. Electric Motors

1. Retractable seating system shall be driven by a friction drive mechanism fixed to the underside of the first platform.
2. 4 rubber roller chains will be driven by 3-phase a-synchronous reduction motors.
3. Motor power shall be provided via 3-phase receptacles located in the rear wall of the platform storage alcove.
4. Coordinate all electrical requirements with the Electrical Contractor.
5. Control of the retractable seating system shall be via a low voltage control pendant.
6. A pendant receptacle shall be concealed in the front of the first platform.
7. The pendant control shall enable both deployment and storage of the platform system, as well as left/right motor control adjustment to provide operator control over alignment should the system require it.
8. Entire motor unit shall be UL listed.
9. Provide a 25'-0" cable with the control pendant.

K. Aisle Lights

1. Provide UL approved low voltage warm white LED aisle lighting fixtures for installation centered in face of intermediate aisle risers.
2. Provide nose mounted low voltage fixture. Provide required transformers to be mounted within the telescopic platform system.
 - a. Aisle lighting shall comply with all local codes with respect to egress path lighting of 0.2 footcandles, continuous along the entire egress path, or as required for public assembly seating at the time of contract.
3. Step lights shall be provided on intermediate steps and telescoping steps
 - a. Intermediate steps shall have a coiled cord and plug that mates to a receptacle on seating riser face arranged so that installed step covers the cord, plug and receptacle. Cord shall have length sufficient to install and remove step and plug.
4. Aisle light dimming shall be controlled by the theatrical lighting system via DMX-512
5. Provide contact switches at each telescopic riser row arranged to switch on aisle lights for deployed rows only.

2.6 SEATING

A. Upholstered Chairs

1. The basis of design for the upholstered chair shall be the following with special components as indicated herein or an approved equal:
 - a. Studio Theatre
 - 1) Basis of design appearance:
 - (a) Jezet model TBD (Livio equivalent)
 - 2) Upholstered back with wood back panel, Finish TBD
 - 3) Upholstered seat with wood bottom, Dark Finish TBD
 - 4) Solid wood arm rests on steel supports, Finish TBD
 - 5) Exposed metal finish to be selected by Architect
 - 6) Fabric: per Architect
 - (a) Color TBD
 2. General:
 - a. The chair seating system shall be a self-storing system allowing individual chairs to fold down or be raised into a locking position on individual T-shaped tubular steel supports. A foot pedal shall be provided at each single tube stanchion to lock/unlock the chair assembly position.
 - 1) An inclined central tube of 40mm x 40mm x 3mm steel shall be welded to a 40mm x 40mm x 3mm horizontal tube.
 - 2) Two seat holders shall be welded to the horizontal tube.
 - 3) The back shall be mounted to the support by two ribbed pins.
 - 4) The supports shall be bolted to a foot which will contain the folding and locking mechanism.
 - 5) The foot shall be bolted to the platform with 4 bolts, nuts and washers.
 - b. All component parts of chair modules (except stanchions) shall be interchangeable for telescopic platform chairs.

- c. Seats and backs shall have internally supported peripheral heavy gauge steel frames. The frames shall support, resist and transmit design loads to the rectangular steel chair stringer without excessive deflection of noise.
3. Seat Bottom:
 - a. The seat bottom 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.
 - b. Smoothly round corners, edges, and exposed fasteners, to present least possible snagging and pinching hazards.
 - c. Seats shall be automatic lift with for ease of row passage and janitorial access. Chairs shall have 100% seat bottom and arm fold.
 - d. Provide heavy-duty steel hinges of compensating type, each equipped with noiseless adjustable seat lifting device; provide for seat rotation on bushings which do not require lubrication, and have a positive internal return stop of rubber or neoprene.
 - e. The seat upholstery shall be without wetting.
 - f. The underside of the seats shall be exposed finished plywood with no exposed hardware or fully upholstered with same fabric as other components as required for each space.
 4. Backs:
 - a. Fabricate back as padded, upholstered component with ergonomically shaped plywood back panel.
 - b. Provide hardwood veneer ply rear panel.
 - c. The upholstery panel shall be comprised of a medium density virgin urethane foam, not less than 1" thick, on a precision die tempered hardboard backer fitted with concealed nylon fasteners. The fabric cover shall be tensioned over and neatly enclose both foam and backer.
 - d. The back upholstery unit shall be removable for service without the necessity of chair back disassembly.
 5. Chair Standards:
 - a. The chair standards shall be fabricated of continuously welded closed seam steel tube.
 - b. The standards will be engaged in pivotal, riser support brackets. Each chair module will be supported between two standards on a central stanchion. The pivotal brackets shall automatically lock the chair in the upright use position and the seat deploy shall actuate arm rests.
 - c. Manual operation (with pneumatic assisted stanchions) system to raise groups of chairs (up to a maximum of 4 chairs at one time). Unlocking shall be done from a foot lever at the central stanchion.
 6. Arm Rests:
 - a. Provide arm rest at each aisle and between chairs, designed for concealed mounting to standards.
 - b. Arm rests shall be solid hardwood on metal construction or fully upholstered hardwood as required by each space. Sample to be approved by Architect before fabrication.
 - c. The finish color of the arm rests shall be chosen by the Architect from the manufacturer's standard color line of stains and sealers.
- B. Number and Letter Plates:**
1. Provide seat number plates for seat location identification system corresponding to approved shop drawings.
 - a. Plate type and finish to be manufacturer standard and shall be selected by the Architect.
 - b. Font, color and text size information to be provided by the Architect.
 2. Provide row letter plates for seat location identification system corresponding to approved shop drawings.
 - a. Plate type and finish to be manufacturer standard and shall be selected by the Architect.
 - b. Font, color and text size information to be provide by the Architect.
 3. Text fill shall be deep in color and consistent. Characters shall be centered on the plate.
 4. Seat number plates to be recess mounted in the center of the front edge of the seat pan and fastened with rivets.
 5. Fixing shall be by two-part epoxy adhesive.
 - a. If mounting fasteners are approved, they shall match finish of number/letter plates.

- C. 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.

2.7 MOVABLE SEATS

3.0 DONOR PLATES

- A. Donor plates shall be 7/8" wide x 3" long, brushed bronze or aluminum.
- B. Fixing shall be by two-part epoxy adhesive.
- C. Donor plates shall be accommodated for all chairs and shall be located in a recess for flush mounting in all armrests near the rear of the armrest.
- D. Donor 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.

2.8 SOURCE QUALITY CONTROL

- A. All equipment and components to be factory tested prior to shipping.

2.9 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).

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 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.

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 chairs 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 chairs by mounting components to standards or brackets mounted on standards using industry approved hardware and fasteners.

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 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. Retractable Seating System
 - 1) Deploy seating system
 - (a) Conduct visual inspection of all mechanical, electrical and, as required, hydraulic/pneumatic connections
 - (b) Raise and lower all seats on fully deployed system
 - 2) Retract seating system
 - 3) Deploy each row individually and successively, row by row
 - (a) Raise all seats in last deployed row to check that seats fully deploy and that seat bottom/back raise lower function is not limited by stored rows behind it
 - (b) Repeat for each additional deployed row
 - 4) Review aisle light function

3.5 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.

3.6 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. Installed seating shall be compared with the approved mock-up. They shall be identical in all respects.
 - 4. The Theatre Consultant will perform the tests listed in the Compliance Testing Procedures to verify compliance with specifications.

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 six 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 Seating 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. Timing for all sessions shall be scheduled by the Owner at their convenience.

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 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.

END OF SECTION

SECTION 127100 PORTABLE AUDIENCE SEATING

PART 1 GENERAL

1.1 SUMMARY

- A. The work in this section includes portable audience seating within the following spaces:
 - 1. Proscenium Theatre
 - 2. Studio Theatre
 - 3. Valade Jazz Center
- B. Section Includes
 - 1. Furnish the following major elements and associated accessories:
 - a. Portable folding audience seating and accessories
 - b. Transport carts
 - 2. Provide all materials, components and services required to provide the work as specified herein, elsewhere in the Contract Documents and/or as shown on related drawings.
 - 3. 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. Portable audience seating and accessories will be delivered to site, unpacked and assembled for installation by the Owner.
 - 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
 - 1) Section 012300 – Alternates
 - b. Division 11 – Equipment
 - 1) Section 116123 – Platforming
 - c. Division 12 – Furnishings
 - 1) Section 126600 – Retractable Bleacher System and Seating

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 pricing for each type of portable audience chair.
- C. Alternates
 - 1. Provide separate price information for material and labor associated with the following equipment and systems:
 - a. <<TBD>>
 - 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. <<TBD>>

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 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 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.

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.

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. 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. Division 11 – Equipment
 - 1) Section 116123 – Theatrical Platforming
 - 2) Section 116135 – Stage Extension Orchestra Pit Lift System
 - b. Division 12 – Furnishings
 - 1) Section 126600 – Retractable Bleacher System and Seating

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. 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.
- H. 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 complete, fully dimensioned, large scale detailed shop drawings of all major components. Include plan or schedules with quantities of each seat size and all other accessories.
 - 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 a full Bill of Materials to be supplied, including quantities, manufacturer, manufacturer's part number, reference to applicable drawings, etc.
- I. Samples:
 - 1. Submit sample items including, but not limited to:
 - a. Two (2) complete sample seats of each type of seat under this section.
 - 2. Additional samples must be submitted within 14 days of Architect's written request.
- J. Certificates:
 - 1. Provide manufacturer's certificate stating materials meet fire performance characteristics as specified herein.

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. Submit operation and maintenance manuals with the final inventories. 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. Recommendations for cleaning, maintaining and touch-up of all finished surfaces
 - c. Provide specific recommendations for cleaning upholstery, including precautions against materials and methods which could damage upholstery fabric.
 - 4. Where specific elements do not require manuals, instruction sheets as to care and handling shall be provided.
 - 5. Certificates of flame resistance as required herein.

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 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 the 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 fabric or fabric 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.

1.8 QUALITY ASSURANCE

- A. Regulatory Requirements:
 1. Refer to Division 01 – General Requirements.
- B. Qualifications:
 1. All equipment within this specification 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.
 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, 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.

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. Packing should include humidity resistant wrapping with desiccant as appropriate to protect contents. Contractor shall ensure that seating and related materials are delivered to 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 portable audience seating 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 or 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.

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 five (5) years following the date of final acceptance. Ordinary wear and damage due 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:

Wenger Corporation
555 Park Drive, P.O. Box 448
Owatonna, MN 55060
Tel: (800) 493-6437

Ducharme Seating
9275 Royer Street, Leonard
Quebec, Canada H1P 3H7
Tel: (514) 328-2772

- 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 the "TS" series Contract Drawings for seating layout plans and quantities of each type of seat for the following performance spaces. Provide seats noted as "Loose Seats" only.
 1. Proscenium Theatre:
 - a. Portable folding audience seats:
 - 1) Interlocking, folding loose audience chairs with eye tabs at the foot for temporary attachment to the floor
 - 2) Seat bottoms self-rise to a vertical safety position
 - 3) Hanging style storage carts for the total number of seats
 2. Studio Theatre:
 - a. Portable folding audience seats:
 - 1) Interlocking, folding loose audience chairs with eye tabs at the foot for temporary attachment to the floor
 - 2) Seat bottoms self-rise to a vertical safety position
 - 3) Hanging style storage carts for the total number of seats
 3. Valade Jazz Center:
 - a. Portable folding audience seats:
 - 1) Interlocking, folding loose audience chairs with eye tabs at the foot for temporary attachment to the floor
 - 2) Seat bottoms self-rise to a vertical safety position
 - 3) Hanging style storage carts for the total number of seats
- B. 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 DESIGN CRITERIA

- A. Overall front to back envelop with seat in upright position shall not exceed 21" without notifying Architect in writing.
- B. 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.
- C. 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.
- D. Fire Performance Characteristics
 1. Flame Retardant performance: Upholstery components and the assembly thereof shall be in conformance with flammability standards as set forth in California Technical Bulletin #117.
 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:
1. Gray Iron Castings: American Society of Testing Materials A48, Class 25.
 2. Steel Plates, Shapes, and Bars: American Society of Testing Materials A36.
 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.
 5. Concealed Plywood: PS 1/ANSI A199.
- 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 to be selected by the Architect from one of the manufacturer's standard seating fabrics.
 - b. Fabric color shall selected by the Architect from the manufacturer's standard color line.
 - c. Flame Retardant: Meets Class "A" flamespread rating in accordance with American Society of Testing Materials-E84, NFPA #255, UBC #42-1, and Underwriters Laboratory #723.
 - d. Light Fast: Exceeds 48 hour NAFM requirement. Test method A.A.T.C.C.-16A.
 - e. The fabric shall be strengthened with an acrylic or similar backing.
- D. Cushions: Seat and back cushions made of open cell polyurethane foam.
- E. Fasteners: All fasteners shall be concealed. No exposed fasteners permitted.

2.5 PORTABLE FOLDING AUDIENCE SEATING

- A. Provide portable folding audience chairs with the following characteristics:
1. Chair shall be freestanding, folding audience seating with built-in interlocking device.
 2. Chair frame shall be constructed with 16 gauge continuous electric welded 1" x 2" rectangular steel tube.
 3. The frame shall be finished with black powder coat or black epoxy paint.
 4. The arm rest shall be constructed of hardwood with lacquer finish with rounded edges.
 - a. Wood species and finish color to be selected by the Architect.
 5. The seat and back shall be upholstered with a durable 100% polypropylene fabric.
 - a. Fabric and color to be selected by the Architect.
 6. Seat cushion shall be 2-1/2" thick, high-resiliency polyurethane foam with a 5-ply 3/8" contoured hardwood plywood substrate.
 7. Back cushion shall be 1-1/2" thick, high-resiliency polyurethane foam with a 5-ply 3/8" contoured hardwood plywood substrate. Back cushion shall be shaped to provide lumbar support for comfort.
 8. Chair bottom shall be spring-loaded and shall return to a full upright position when not occupied.
 9. Overall chair height shall be 32" with a seat height of 17-1/2".
 10. Chair depth, when seat is in the upright position, shall be 20".
 11. The chairs shall fold for storage on transport carts.
 12. Provide chairs in quantities and widths as shown on the drawings.
 13. Provide:
 - a. Wenger – Standard Portable Audience Chair
 - b. or approved equal

2.6 ROLLING STORAGE / TRANSPORT CARTS

- A. Provide transport carts for portable folding audience seating with the following characteristics:
1. Cart shall store and transport 24 loose chairs.
 2. Cart shall be of steel construction with easy-roll casters.

3. Overall dimensions shall be 70" high x 82" wide x 38" deep.
4. Provide vinyl coated polyester dust cover for cart laden with chairs.

2.7 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 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. Provide site labor to unpack all equipment provided under this Section.
- B. Position all items accurately as indicated on drawings.

3.3 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.

3.4 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 jobsite and disposed of legally at no additional cost to the Owner.

3.5 CLOSEOUT ACTIVITIES

- A. Demonstration
 1. Installed equipment shall be operated for approval and inspected for quality by the Theatre Consultant, the Architect and the Owner.
 2. Adjustments or modifications shall be made as directed by the Architect and the Theatre Consultant.
 3. Cost of re-inspection and additional testing by the Architect, Owner or 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 use, care and maintenance of all items.

2. Deliver all copies of approved Operations Manual to Owner prior to the instruction session, and review it as part of that session.
3. Instruction shall be by technical staff of the Contractor.
4. Schedule instruction in conformance with project construction schedules and the availability of the Owner.

3.6 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.

END OF SECTION

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. ECOPE 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.
 - 1. Basis of Design: QTrbm by ECOPE International.
 - a. Overall Thickness: 1-inch.
 - 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.
 - 2. Closed cell polyethylene. Thickness: 1-inch.
 - 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.
1. Basis of Design: NPS-40 by Mason Industries.
- 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

- A. (SVC-31) Neoprene Waffle Pads: Natural rubber 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 142400 HYDRAULIC ELEVATORS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Service and passenger hydraulic elevator (ELEV-1).
- B. Related Sections:
 - 1. Section 033000 - Cast-in-Place Concrete: Machine Room floor.
 - 2. Mechanical: Pit drainage.
 - 3. Electrical: Electrical power to machine room including main switch and breaker.

1.2 ACTION SUBMITTALS

- A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures; hoistway entrances; and operation, control, and signal systems.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and large-scale details indicating service at each landing; machine room layout; coordination with building structure; relationships with other construction; and locations of equipment.
 - 2. Include large-scale layout of car-control station.
 - 3. Indicate maximum dynamic and static loads imposed on building structure at points of support as well as maximum and average power demands.

1.3 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 system being provided.
- C. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
- B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
- C. Continuing Maintenance Proposal: 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 QUALITY ASSURANCE

- A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.

1.6 PERMIT, TEST AND INSPECTION

- A. Obtain and pay for permit, license, and inspection fee necessary to complete installation.
- B. Perform test required by Governing Authority in accordance with procedure described in ASME A17.2 Guide for Inspection of Elevators, Escalators, and Moving Walks in the presence of Authorized Representative.

- C. Supply personnel and equipment for test and final review by Consultant, as required in Part 3.

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. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Furnish well casing and coordinate delivery with related excavation work.
- C. Coordinate locations and dimensions of other work specified in other Sections that relates to hydraulic elevators, including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
- B. Accessibility Requirements: Comply with Section 407 in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.
- C. Airborne Noise: Measured noise level of elevator equipment and its operation shall not exceed 60 dBA inside car under any condition including door operation and car ventilation exhaust blower on its highest speed. Limit noise level in the machine room relating to elevator equipment and its operation to no more than 80 dBA. All dBA readings to be taken 3'-0" off the floor and 3'-0" from the equipment using the "A" weighted scale.
- D. Vibration Control: All elevator equipment provided under this contract, including power unit, controller, oil supply lines, and their support shall be mechanically isolated from the building structure and electrically isolated from the building power supply and to each other to minimize the possibility of objectionable noise and vibrations being transmitted to occupied areas of the building.

2.2 MANUFACTURERS

- A. Source Limitations: Obtain elevators from single manufacturer. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.
- B. Manufacturers:
 - 1. MEI - Total Elevator Solutions.
 - 2. Kone Elevator Company.
 - 3. Otis Elevator Company.
 - 4. Schindler Elevator Company.
 - 5. ThyssenKrupp Elevator.

2.3 SERVICE AND PASSENGER ELEVATOR

- A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components shall be used, as included in standard elevator systems and as required for complete system.
- B. (ELEV-1) Single-Phase Hydraulic Service Elevator:
 - 1. Basis of Design: Endura A5000 by ThyssenKrupp.
 - 2. Net Capacity: 5000 lbs.
 - 3. Speed: 150 fpm.

4. Openings: , front.
 5. Stops:
 6. Travel: feet
 7. Entrance Openings Size: ___'-___" by 7'-0".
 8. Platform Size: ___'-___"
 9. Pit Depth: ___ inches
- C. Elevator Operation:
1. Simple collective single car automatic operation.
 2. Independent operation with key lock to remove car from normal hall button calls.
 3. Home landing shall be main floor.
- D. Fire Emergency Service:
1. Elevator operation shall comply with requirements of local code.
 2. Fire key shall be kept in suitable emergency box mounted adjacent to elevator.
 3. If smoke or heat sensing devices are wired to elevator system to initiate foregoing operation, install three position key switch, third position to override automatic initiation by sensing device.
- E. Additional Features:
1. Anti-Stall Feature
 2. Braille and Audible Signals
 3. Door Open and Close Stall Protection
 4. Emergency Lighting
 5. Firefighter 's Service, sensors by others
 6. Independent Service Feature
 7. Infrared Light Curtain Door Protection
 8. Low Oil Return
 9. Overload Sensors
 10. Phase Protection
 11. Start Type: Across the Line
 12. Locking Service Panel in Car Operating Panel
 13. Remote Monitoring Capable
 14. Telephone (ADA compliant)

2.4 CAR ENCLOSURES

- A. Car Enclosures, General: Provide enameled-steel car enclosures to receive removable wall panels, with car roof, access doors, power door operators, and ventilation.
- B. Inside Clear Dimensions (Nominal):
1. Inside Width: 6'-0" from side wall to side wall.
 2. Inside Depth: 9'-0" from back wall to front wall (return panels).
 3. Inside Height: 8'-6" to underside of ceiling.
- C. Front Walls (Return Panels) with Integral Car Door Frames: Satin stainless steel, No. 4 finish.
- D. Car Fixtures: Satin stainless steel, No. 4 finish.
- E. Side and Rear Wall Panels: Satin stainless steel, No. 4 finish.
- F. Wall Panel Reveals: Satin stainless steel, No. 4 finish.
- G. Door Faces (Interior): Satin stainless steel, No. 4 finish.
- H. Door Sills: Aluminum, mill finish.
- I. Ceiling and Light Fixtures: Satin stainless steel panels, No. 4 finish, with recessed lighting fixtures.
- J. Handrails: Satin stainless steel, No. 4 finish, 1/2 by 2 inches rectangular, at sides and rear of car.
- K. Floor: Prepared to receive resilient floor tile (RSF). Coordinate with Section 096500.
1. Rubber Sheet Flooring: Norament Arago, 5178 Calm.
- L. Additional Requirements:

1. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
2. Provide hooks for protective pads in elevator and one complete set(s) of full-height protective pads.

2.5 HOISTWAY ENTRANCES

- A. Hoistway Entrance Assemblies, General: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoistway wall construction.
- B. Dimensions of Hoistway Opening:
 1. Width:
 2. Height:
- C. Frames: Satin stainless steel, No. 4 finish.
- D. Hoistway Door Type: Two-speed, side-opening.
- E. Hoistway Doors: Satin stainless steel, No. 4 finish.
- F. Sills: Aluminum, mill finish.
- G. Hall Fixtures: Satin stainless steel, No. 4 finish.

2.6 OPERATING EQUIPMENT

- A. Motors, pumps, controllers, hydraulic fluid reservoir, cylinder, casing, plunger, piping, guide rails, buffers, buttons, wiring, indicators, and hardware and fittings to provide fully operational elevator.
- B. Back-up power source: Provide with standby power source unless elevator is shown to be connected to emergency power generator.
- C. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.
 1. Card-Reader Operation: System uses card readers at car-control stations to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space as indicated for card reader in car.
 - a. Provide at Lower Level.
 - b. Security Access Equipment: Refer to Division 28.
 - c. Coordinate with Section 087100 - Door Hardware and Division 26.

2.7 EQUIPMENT AND COMPONENTS FOR VIBRATION CONTROL

- A. Hydraulic Pumps and Oil Storage Tanks: Mount on Type M-1 multi-layer bridge-bearing neoprene pads or Type M-2 neoprene base mount isolators. Size isolators for not less than 0.3 inch static deflection.
- B. Hydraulic Lines:
 1. Isolate entire length of hydraulic lines from the building structure using Type M-2 bridge-bearing neoprene mounts or Type H-2 hangers. Size isolators for not less than 0.3 inch static deflection.
 - a. Type M-1 Mounts - Neoprene Pads
 - 1) 3/4"-inch minimum thickness, waffled or ribbed neoprene.
 - 2) 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.
 - 3) Acceptable products for individual pads include:
 - (a) Mason W, SW, and Super W
 - (b) Kinetics NP
 - (c) The VMC Group NRC Pads

- 4) Acceptable products for neoprene/steel composite pads include:
 - (a) Mason WSW
 - (b) Vibration Mountings and Controls Group NRC Flex Plates
 - (c) RPG Custom Elastomeric/Steel Composite Pads
 - b. Type M-2 Mounts - Neoprene-in-Shear Mounts
 - 1) 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.
 - 2) Design isolators for 0.25 to 0.35 inches of deflection. Acceptable products include
 - 3) Acceptable products include:
 - (a) Mason ND
 - (b) Kinetics RD
 - (c) The VMC Group RDC2
 - c. Type H-2 Hangers - Neoprene-in-Shear Hangers
 - 1) 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.
 - 2) For ductwork hung by straps, provide hangers with eyes on the top and bottom to allow for bolting to the straps.
 - 3) Acceptable products include:
 - (a) Mason HD and WHD
 - (b) Kinetics RH
 - (c) The VMC Group HR
 2. Connect hydraulic lines using braided stainless steel hose installed parallel to the equipment drive shafts. Provide hose length not less than 20 times its diameter. Provide carbon steel flanges for pipes greater than 3 inches diameter. Male nipples are acceptable for pipe diameters smaller than 3 inches.
 - a. Flexible Braided Stainless Steel Hose:
 - b. Acceptable products include:
 - 1) Mason FFL and MN
 - 2) Kinetics Kinflex BFMC
 - 3) The VMC Group Group SS
- C. Conduit:
1. Provide flexible connectors for conduit 2 inches in diameter and larger:
 - a. Acceptable products include:
 - 1) Crouse Hinds type XD Expansion/Deflection Coupling
 - 2) OZ/Gedney type DX
 - 3) Anaconda Sealtite
 2. Flexible steel Conduit for conduit less than 2 inches in diameter.
 - a. Flexible conduit will be at least 18 inches long in a slack "U" shaped loop.
 - b. Provide U.L listed flexible zinc-coated steel conduit. Provide liquid tight coating and fittings where required under Division 26.
 - c. Acceptable Products include:
 - 1) American Flexible Conduit Company Type AC-90
 - 2) International Flexible Hose Company Type RWS
 - 3) Liquid Tight Flexible Steel Conduit:
 - 4) Anaconda Sealtite Type UA
 - 5) Electri-Flex Type LT Liguatight

2.8 MATERIALS

- 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. Run grain of belting in direction of longest dimension.

- D. Aluminum: ASTM B221 extruded alloy; ASTM B209 sheet alloy 6063; enameling (anodizing) quality.
- E. 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. Halogens.
 - 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

2.9 FINISHING

- A. Non-exposed to View Surfaces:
 - 1. Structural and Non-exposed Ferrous Metal Surfaces: Free surfaces of rust, oil or grease, clean with solvent, prime with 2 coats structural steel grade primer.
 - 2. Field Welds: Chip and clean away oxidation, flux or residue, wire brush clean, apply 2 coats of primer.
 - 3. Wood: One coat primer and 2 coats semi-gloss low VOC enamel.
- B. Exposed to View Surfaces (in car, machine room and hoistway entrances).
 - 1. Stainless Steel: Type 302/304 No. 4 finish.
 - 2. Baked Enamel: Clean, degrease zinc coated metal surface, one coat of zinc oxide primer sprayed and baked, 2 coats of semi-gloss enamel sprayed and baked, color as selected from manufacturer's standard range.
- C. Primer: Shop coat, (zinc dust/zinc oxide) alkyd.
- D. Galvanizing: ASTM A526, G90 coating designation.
- E. Enamel: Shop applied baked enamel of colors selected by Architect.
- F. Corrosion Protection: Corrosive resistant paint and covering wrap as recommended by elevator manufacturer for specific soil conditions at site.
- G. Machine Room: At the completion of the elevator installation, paint machine room and pit floors with Rust-Oleum water-based epoxy paint. Color to be grey. Refer to Section 099000 - Painting.

2.10 FABRICATION

- A. Machine: A.C. type specifically designed for elevator service having motor, pump, tank valves and muffler mounted and aligned on steel bedplate.
- B. Cylinder/Plunger: Machined polished steel tube having internal couplings where jointed, welded stop on bottom, sliding in high strength steel pipe cylinder having closed bottom and stuffing box with packing gland at top and necessary piping connections.
- C. Car: Sheet steel enclosure with structural steel frame and bracing, 3/4 inch fire retardant treated plywood floor and wall cladding fastened with hidden mechanical fasteners. Power operated hollow steel doors with track, rollers and frame.

PART 3 EXECUTION

3.1 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.
- 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.
- C. Ensure that machine room is properly illuminated, heated and ventilated and equipment foundations correctly located complete with floor and access door.
- D. 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.
- E. 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 in pit and outlets in machine room for light. 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.
 - 4. Machine room enclosed and protected from moisture, with lockable door.
- F. Supply in ample time for installation, inserts, anchors, pipe sleeves, bearing plates, brackets, supports and bracing including setting templates and diagrams for placement.

3.2 INSTALLATION

- A. Perform work with competent mechanics skilled in this work and under direct control and supervision of elevator manufacturer's experienced foreman.
- B. Set hoistway entrances in alignment with car openings and true with plumb sill lines.
- C. 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.
- D. Excavate for plunger and cylinder, set in place plumb and accurate and enclose with 3000 psi concrete.
- E. Mount machine immediately adjacent to hoistway on concrete foundation provided under Section 033000 - Cast-in-Place Concrete. Isolate and dampen machine vibration with properly sized sound reducing anti-vibration pads.
- F. Install and hookup piping between machine and cylinder.
- G. Erect hoistway sills, headers and frames prior to erection of rough walls and doors; erect fascias and toe guards after rough walls finished.
- H. Grout sills and hoistway entrance doors.
- I. Provide stainless steel license holders in each elevator car to suit certificate issued. Design holder with nonvisible tamperproof fastenings.
- J. Provide wall hooks and protective mats for walls of one elevator car as selected.
- K. Locate hall buttons and indicators as detailed on drawings,

3.3 INSTALLED WORK

- A. Adjust and Balance: Make necessary adjustments of equipment to ensure elevator operates smoothly and accurately.
 - 1. 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.
- B. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.
 - 1. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.
- C. Inspection:
 - 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, hoisting enclosure and machine room are complete.
 - 3. Inspect installation in accordance with ANSI A17.2.
 - 4. Deliver test certificates and permits to Architect.
- D. Protection: Locate and protect moveable equipment and controls in such way that they can only be operated by authorized persons.
- E. Temporary Use: Comply with the following requirements for elevator used for construction purposes:
 - 1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
 - 2. Provide strippable protective film on entrance and car doors and frames.
 - 3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
 - 4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
 - 5. Do not load elevators beyond their rated weight capacity.
- F. Cleaning: Prior to final acceptance remove protection from finished or ornamental surfaces and clean and polish surfaces with due regard to type of material.
- G. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of elevator Installer.
 - 1. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Perform maintenance during normal working hours.
- H. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).
- I. Instruction: 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.

END OF SECTION

SECTION 144200 WHEELCHAIR LIFTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vertical wheelchair lift (ELEV-3).
 - 2. Motor, controls and wiring.
- B. Related Sections:
 - 1. Section 142400 - Hydraulic Elevator.
 - 2. 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.

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.
- B. Regulatory Requirements: Comply with ASME A18.1, "Safety Standard for Platform Lifts and Stairway Chairlifts."

2.2 MANUFACTURERS

- A. Manufacturers:
 1. Ascension; a Division of AGM Container Controls, Inc..
 2. Cambridge Elevating, Inc..
 3. Garaventa Lift.
 4. Harmar.
 5. Inclinator Company of America, Inc..
 6. Lift-U; a Division of Hogan Mfg, Inc..
 7. Liftavator, Inc..
 8. Nation Wide Lifts.
 9. Savaria.
 10. Symmetry Elevating Solutions
 11. T.L. Shield & Associates, Inc..
 12. Vertechs.
 13. Bramalea Elevator, LTD..

2.3 PERFORMANCE VERTICAL LIFT

- A. (ELEV-3) Vertical Platform Lift and Enclosure:
 1. Basis of Design: Model VPC-EL by Symmetry Elevating Solutions.
 - a. Approved Supplier and Installer: Arrow Lift; Blaine, Minnesota.
 2. Number of Stops: Two.
 3. Platform Size: 36 by 54 inches.
 4. Rated Speed: 10 fpm.
 5. Electric Power Supply: 1 HP; 115-V ac, single phase, 60 Hz.
 6. Emergency Operation: Provide manual operation and battery power system to raise or lower unit to a landing in case of malfunction or power loss.
 7. Self-Supporting Unit: Support vertical loads of unit only at base, with lateral support only at landing levels.
 8. Runway Enclosure: Manufacturer's standard enclosure assembly.
 - a. Runway Enclosure: Rectangular steel-tube frame with flush steel-sheet panels.
 - b. Runway-Enclosure Doors: Rectangular steel-tube frame with flush steel-sheet panels.
 9. Platform: Steel sheet or galvanized-steel sheet with manufacturer's standard black rubber flooring.
 10. Platform Enclosure and Door: Rectangular steel-tube frame with flush steel-sheet panels.
 11. Ramp: Fixed ramp matching platform to provide transition from floor to lift platform at bottom landing.
 12. Accessories: Provide units with the following accessories:
- B. Lift Mechanism: Electric mechanism, no hydraulics permitted. Carry lifting forces on 4 steel screw columns connected to platform for maximum stability.
 1. Power Requirements: Install dedicated breaker protected service 115 VAC, 3-wire, 15 amp, single-phase service supplied from building power source. Dedicated breaker protected service supplied by Owner or Owner's Representatives.

2. Limit Switches: Equip lift with redundant upper and lower limit switches. Provide mechanical stops to limit travel in both directions.
- C. Operation: Low voltage (24 VDC) operated with constant pressure control switches, designed to be easily operated by a person with limited dexterity according to ADA requirements.
1. Controls: Equip lift with controls at the top, bottom landing and platform. Provide a security key switch to control unauthorized use.
 2. Emergency Stop Button: Provide an illuminated emergency stop button on platform control panel.
 3. Emergency Alarm System: Audible alarm that is automatically activated when the emergency stop button is depressed.
 4. Limit Switches: Equip lift with redundant upper and lower limit switches.
 5. Battery: Provide backup battery
 6. Manual Lowering Device: Provide device to manually lower or raise the platform.

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
- F. Provide platform with 4 corner support for maximum stability.
- G. Factory Finish: Corrosion resistant coating, custom color as selected by Architect.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, critical dimensions, and other conditions affecting performance of the Work.
- B. Minimum Headroom Clearance: Verify that installed lift will have a minimum headroom of 80 inches above any point on platform floor at any point of travel.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Installation, General: Comply with ASME A18.1 and manufacturer's written instructions for installation of lifts unless otherwise indicated.
- B. Wiring Method: Conceal conductors and cables within housings of units or building construction. Do not install conduit exposed to view in finished spaces. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- C. Coordinate runway doors with platform travel and positioning, for accurate alignment and minimum clearance between platforms, runway doors, sills, and door frames.
- D. Position sills accurately and fill space under sills solidly with nonshrink, nonmetallic grout.
- E. Coordinate platform doors with platform travel and positioning.
- F. Adjust stops for accurate stopping and leveling at each landing, within required tolerances.
 1. Leveling Tolerance: 1/4 inch up or down, regardless of load and direction of travel.

- G. Adjust retractable ramps to meet maximum allowable slope and change-in-elevation requirements, and to lie fully against landing surfaces.
- H. Lubricate operating parts of lift, including drive mechanism, guide rails, hinges, safety devices, and hardware.
- I. Test safety devices and verify smoothness of required protective enclosures and other surfaces.

3.3 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.

3.4 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.

3.5 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



WAYNE STATE UNIVERSITY

Gateway Theater Complex

WSU No. 189-178578 | HAA No. 2016034.00

Project Manual

Volume 2 of 4

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22 - Plumbing

23 - Heating, Ventilating & Air Conditioning

100% Design Development

January 30, 2019

HGA

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- 331100 Water Main
- 333100 Facility Sanitary Sewers
- 334100 Storm Sewers, Underdrains & Drainage Structures

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, 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 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. Manufacturers 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 manufacturer's recommendations and is operating as specified. Included test data.
- B. Coordination Drawings: Submit one copy for the engineer's 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.
- C. Standard Mechanical Couplings: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183. Couplings shall comply with ASTM F1476 – Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
 - 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.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

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.
- E. 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.

- 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:
 - 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. Defense Security Service Office of the Designated Approving Authority – Master System Security Plan (MSSP) Template for Peer-to-Peer Networks (June 2011, Version 3.0).
 - 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.
 - 3. Vibration Isolation/Seismic Restraint.
 - 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
 - 2. National Fire Protection Associations (NFPA).
 - 3. Underwriter's Laboratories, Inc. (UL).
 - 4. American National Standards Institute (ANSI).
 - 5. American Society of Testing Materials (ASTM).
 - 6. American Society of Mechanical Engineers (ASME).
 - 7. American Welding Society Code (AWSC).
 - 8. American Water Works Association (AWWA).
 - 9. Compressed Gas Association (CGA).
 - 10. Cast Iron Soil Pipe Institute (CISPI).
 - 11. Manufacturers Standardization Society (MSS).
 - 12. National Bureau of Standards (NBS).
 - 13. Plumbing and Drainage Institute (PDI).
 - 14. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
 - 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:
 - a. Contract price adjustment.
 - 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.
 - 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 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 fire 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.
 - 3. Sleeve-seal fittings.
 - 4. Grout.

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

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement 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:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - 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:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - 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.
 - 3. Set valves open to minimize exposure of functional surfaces.
- 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.

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.
 - 2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.
 - 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.
 - 2. Minimum Pressure Rating: 175 psig.
 - 3. Body Design: Two piece.
 - 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.
 - 12. End Connections for Valves NPS 2-1/2: Grooved 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.
 2. Minimum Pressure Rating: 300 psig.
 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)
 3. Globe Fire Sprinkler Corporation (www.globesprinkler.com)
 4. Kennedy Valve Company; a division of McWane, Inc. (www.kennedyvalve.com)
 5. Matco-Norca (www.matco-norca.com)
 6. Mueller Co. (www.muellercompany.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)
 11. Venus Fire Protection, Ltd. (www.venus-fire.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:
1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
 2. Minimum Pressure Rating: 250 psig.
 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.
 9. Hinge Spring: 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:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
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.
9. End Connections: Threaded.

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:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
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:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
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)

4. Mueller Co. (www.muellercompany.com)
5. NIBCO, Inc. (www.nibco.com)
6. Victaulic Company (www.victaulic.com)

B. Description:

1. Standard: UL 789 and FM Global standard for indicator posts.
2. Type: Wall.
3. Base Barrel Material: Cast or ductile iron.
4. Cap: Cast or ductile iron.
5. Operation: Wrench.

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:
 - a. Pressure Rating: 175 psig.
 - 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:
 - a. Fire Protection Products, Inc. (www.fppi.com)
 - b. NIBCO, Inc. (www.nibco.com)
 - c. United Brass Works, Inc. (www.ubw.com)
2. Description:
 - a. Pressure Rating: 175 psig.
 - 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:
 - a. Pressure Rating: 175 psig.
 - b. Body Material: Bronze with integral seat and screw-in bonnet.
 - 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 standpipes.
 - 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."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 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)
 - 3. Bergen-Power Pipe Supports (www.pipesupports.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)
 - 8. Globe Pipe Hanger Products, Incorporated (www.globepipehanger.com)
 - 9. National Pipe Hanger Corporation (www.nationalpipehanger.com)
 - 10. PHD Manufacturing, Incorporated (www.phd-mfg.com)
 - 11. PHS Industries, Incorporated
 - 12. Piping Technology & Products, Incorporated (www.pipingtech.com)
 - 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.mktfastening.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.mktfastening.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.
 1. Properties: Non-staining, noncorrosive, and nongaseous.
 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-joint 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.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

- 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.
- B. Letter Color: White.
- 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."
4. Color: Red background with white lettering.

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.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label Color Schedule:
 1. Fire Suppression Piping:
 - a. Background Color: Red.
 - b. Letter Color: White.

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:
 - a. Sprinkler Water: 1-1/2 inches round.
 - b. Compressed Air: 1-1/2 inches round.
 2. Valve-Tag Color: Red
 3. Letter Color: White.

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)
 - 3. Fire Protection Products, Inc. (www.fppi.com)
 - 4. Fire-End & Croker Corporation (www.croker.com)
 - 5. GMR International Equipment Corporation (www.gmr-fire.com)
 - 6. Guardian Fire Equipment, Inc. (www.guardianfire.com)
 - 7. Venus Fire Protection Ltd. (www.venus-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)
 - 4. Guardian Fire Equipment, Inc. (www.guardianfire.com)
 - 5. Potter Roemer LLC (www.potterroemer.com)
 - 6. Venus Fire Protection Ltd. (www.venus-fire.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.

END OF SECTION

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.
 - 4. Alarm devices.
 - 5. Manual control stations.
 - 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.
- M. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- N. Malleable- or Ductile-Iron Unions: UL 860.
- O. Cast-Iron Flanges: ASME B16.1, Class 125.
- P. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- Q. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- 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.
- D. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.
- 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.
 3. Ball-and-socket, metal-to-metal, bronze seating surface.
 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:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by 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)
2. Standard: UL 193.
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)
2. Standard: UL 1726.
3. Pressure Rating: 175 psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.8 HOSE CONNECTIONS

A. Adjustable-Valve Hose Connections:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkhart Brass Mfg. Company, Incorporated (www.elkhartbrass.com)
 - 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: **<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:
 - a. Elkhart Brass Mfg. Company, Incorporated (www.elkhartbrass.com)
 - 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.vikiingcorp.com)
 - e. **<Insert manufacturer's name>**.
2. Standard: UL 753.
3. Type: Mechanically operated, with Pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.
5. Size: 10-inch diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: NPS 3/4.
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:
 - a. Fire-Lite Alarms, Incorporated; a Honeywell International Company. (www.firelite.com)
 - b. Notifier; a Honeywell International Company. (www.notifier.com)
 - c. Potter Electric Signal Company. (www.pottersignal.com)
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 6-inch minimum.
5. Size: **[6-inch minimum] [8-inch minimum] [10-inch]** diameter.
6. 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 (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)
2. Standard: UL 346.
 3. Water-Flow Detector: Electrically supervised.
 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.
 6. Pressure Rating: 250 psig.
 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)
 - c. Tyco Fire & Building Products LP. (tyco-fire.com)
 - d. United Electric Controls Company (www.ueonline.com)
 - e. Viking Corporation. (www.vikingcorp.com)
 2. Standard: UL 346.
 3. Type: Electrically supervised water-flow switch with retard feature.
 4. Components: Single-pole, double-throw switch with normally closed contacts.
 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)
 - b. Kennedy Valve; a division of McWane, Incorporated (www.kennedyvalve.com)
 - c. Potter Electric Signal Company. (www.pottersignal.com)
 - d. System Sensor; a Honeywell company. (www.systemsensor.com)
 2. Standard: UL 346.
 3. Type: Electrically supervised.
 4. Components: Single-pole, double-throw switch with normally closed contacts.
 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)
 - b. System Sensor; a Honeywell company. (www.systemsensor.com)
 - c. <Insert manufacturer's name>.
 2. Standard: UL 346.
 3. Type: Electrically supervised.
 4. Components: Single-pole, double-throw switch with normally closed contacts.
 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)
 - 3. Brecco Corporation. (www.breccocorp.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.
 - 2. Alarm Valves: Install bypass check valve and retarding chamber drain-line connection.
 - 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; grooved-end-pipe couplings; 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; grooved-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.
 - 3. Sprinklers.
 - 4. Alarm devices.
 - 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. LEED Submittals:
 - 1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content and chemical components.
- C. Shop Drawings: For wet-pipe sprinkler systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.
- D. 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:
 1. NFPA 13.
- 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.
 - 13) Café / Catering Kitchen: 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) Loading Dock: Ordinary Hazard, Group 2.
 - 19) Stage: Extra Hazard, Group 2.
 - 20) Studio Theater: Ordinary Hazard, Group 2.
 - 21) 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.
- B. Galvanized and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- C. Galvanized and Uncoated, Steel Couplings: ASTM A 865/A 865M, threaded.
- D. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- E. Cast-Iron Flanges: ASME 16.1, Class 125.
- 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.
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - 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.
- G. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
 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:
 - a. Anvil International, Incorporated. (www.anvilintl.com)
 - 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.
- 3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 536, ductile-iron casting; with dimensions matching steel pipe. Short pattern, with flow equal to standard pattern fittings.
- 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:
 - 1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
- 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)
 - 2. Standard: UL 193.
 - 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)
 - 2. Standard: UL 1726.
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Type: Automatic draining, ball check.
 - 5. Size: NPS 3/4.
 - 6. End Connections: Threaded.

2.5 SPRINKLER PIPING SPECIALTIES

- A. Branch Outlet Fittings:
 - 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. Tyco Fire & Building Products (tyco-fire.com)
 - d. Victaulic Company (www.victaulic.com)
 - 2. Standard: UL 213.
 - 3. Pressure Rating: 175 psig-minimum.
 - 4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
 - 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 following:
 - a. Reliable Automatic Sprinkler Co. Inc. (www.reliablesprinkler.com)
 - b. Tyco Fire & Building Products (tyco-fire.com)
 - c. Victaulic Company (www.victaulic.com)
 - 2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
 - 3. Pressure Rating: 175-psig minimum.
 - 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 following:
 - 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.
 - 3. Pressure Rating: 175 psig.
 - 4. Body Material: Brass.
 - 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 following:
 - a. Victaulic Company (www.victaulic.com)
 - b. Viking Corporation (www.vikingcorp.com)
 - 2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
 - 3. Pressure Rating: 175-psig minimum.
 - 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
 - 2. Standard: UL 1474.
 - 3. Pressure Rating: 250-psig minimum.
 - 4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
 - 5. Size: Same as connected piping.

6. Length: Adjustable.
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.victaulic.com)
2. Standard: UL 1474.
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.
4. Pressure Rating: 175-psig minimum.
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.victaulic.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:
 - a. Reliable Automatic Sprinkler Company, Incorporated.
 - 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.
 - 2. Standard: UL 464.
 - 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.
 - 2. Standard: UL 346.
 - 3. Water-Flow Detector: Electrically supervised.
 - 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.
 - 6. Pressure Rating: 250 psig.
 - 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.
 - 2. Standard: UL 346.
 - 3. Type: Electrically supervised water-flow switch with retard feature.
 - 4. Components: Single-pole, double-throw switch with normally closed contacts.
 - 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.
 - 2. Standard: UL 346.
 - 3. Type: Electrically supervised.
 - 4. Components: Single-pole, double-throw switch with normally closed contacts.

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.
 - b. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
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. 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. 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. 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."
- O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."
- P. 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.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

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.
 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 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.

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, Dance Storage, 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.
 - 2. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
 - 3. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
 - 4. Wear Rings: Replaceable bronze.
 - 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:
 - 1. Standard: Comply with requirements in NFPA 20.
 - 2. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
 - 3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
 - 4. Automatic Drain Valve: UL 1726.

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

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement 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 tapings.
- 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.com)

- 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.
 - 6. Line Shaft Bearings: Corrosion resistant, oil lubricated.
 - 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.
- D. Motor: Single speed with permanently lubricated ball bearings. Comply with requirements in Division 21 "Common Motor Requirements for Fire Suppression Equipment."
 - 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

SECTION 213900 CONTROLLERS FOR FIRE-PUMP DRIVERS

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. Full-service, **[full]** **[reduced]**-voltage controllers rated 600 V and less.
 - 2. Limited-service controllers rated 600 V and less.
 - 3. Variable-speed fire-pump controller.
 - 4. Controllers for diesel-drive fire pumps.
 - 5. Controllers for pressure-maintenance pumps.
 - 6. Remote alarm panels.
 - 7. Low-suction-shutdown panels.

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. 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)
 - 6. Master Control Systems, Inc. (www.mastercontrols.com)
 - 7. Metron Control Products div. Hubbell Industrial Controls (www.metroninc.com)
 - 8. 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.
 - 2. Magnetic Controller: Wye-delta (open transition) type.
 - 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 multiline 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.
 - 4. Operator Interface Communications Ports: USB, Ethernet, and RS485.
- 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.
9. Non-automatic (manual, nonelectric) means of transfer.
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)
 6. Master Control Systems, Inc. (www.mastercontrols.com)
 7. Metron Control Products div. Hubbell Industrial Controls (www.metroninc.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.
 3. Hand-off-auto selector 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)
 6. Master Control Systems, Inc. (www.mastercontrols.com)
 7. Metron Control Products div. Hubbell Industrial Controls (www.metroninc.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 requirements 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

SECTION 220500 COMMON WORK RESULTS FOR PLUMBING

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. Manufacturers 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:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
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.
 3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type 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 Thermoplastics.
- 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.
 - 3. Packaging: Premixed and factory packaged.

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.
- E. 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.
- 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.
 - 4. Wet Piping Systems: Install dielectric nipple fittings 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

- A. Comply with joint-sealant materials and applications specified in Division 07 "Firestopping," Division 07 "Fire-resistant Joint Sealants," Division 07 "Joint Protection," and Division 09 "Gypsum Board: Acoustical 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:
 - 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. Defense Security Service Office of the Designated Approving Authority – Master System Security Plan (MSSP) Template for Peer-to-Peer Networks (June 2011, Version 3.0).
4. IEC 62443: Industrial Network and System Security

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 prepared 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.
 3. Vibration Isolation/Seismic Restraint.
 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
 2. National Fire Protection Associations (NFPA).
 3. Underwriter's Laboratories, Inc. (UL).
 4. American National Standards Institute (ANSI).
 5. American Society of Testing Materials (ASTM).
 6. American Society of Mechanical Engineers (ASME).
 7. American Welding Society Code (AWS).
 8. American Water Works Association (AWWA).
 9. Compressed Gas Association (CGA).
 10. Cast Iron Soil Pipe Institute (CISPI).
 11. Manufacturers Standardization Society (MSS).
 12. National Bureau of Standards (NBS).
 13. Plumbing and Drainage Institute (PDI).
 14. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
 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:
 - a. Contract price adjustment.
 - 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.
 - g. Manufacturer's specifications and installation instructions.
- B. Shop Drawings:
1. Prepare plumbing 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 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 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 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.
- E. Rotor: Random-wound, squirrel cage.
- 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

SECTION 220517
SLEEVES AND SLEEVE SEALS 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. 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

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement 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:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - 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:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
 - 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - 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. Marshalltown
 - 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.
 - 4. Case Form: Adjustable angle.
 - 5. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
 - 6. Stem: Aluminum and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
 - 7. Display: Digital.
 - 8. Accuracy: Plus or minus 1 degree F.

2.2 THERMOWELLS

- A. Thermowells:
 - 1. Standard: ASME B40.200.
 - 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
2. Standard: ASME B40.100.
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.
8. Pointer: Dark-colored metal.
9. Window: Glass.
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.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- 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 B16.5 for flanges on steel valves.
 - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 5. ASME B16.18 for solder-joint connections.
 - 6. ASME B31.9 for building services piping valves.
- A. NSF Compliance: NSF 61 Annex G for valve materials for potable-water service.
- 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:
 - a. Standard: MSS SP-110.
 - 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.
- D. NSF Compliance: NSF 61 Annex G for valve materials for potable-water service.

- 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.
 - 2. Handlever: For valves NPS 6 and smaller.
 - 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.norriseal.com)
 - n. Red-white Valve Corporation (www.redwhitevalvecorp.com)
 - o. Spence Strainers International (www.ssiequipment.com)
 - p. Stockmam; 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.

- d. Stem: Two-piece stainless steel.
- 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:
 1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
 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 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 B16.10 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.
- D. NSF Compliance: NSF 61 Annex G for valve materials for potable-water service.

- 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.
 - d. Body Material: ASTM B 62, bronze.
 - 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. Macomb Groups (The) (www.macombgroup.com)
 - i. Milwaukee Valve Company. (www.milwaukeevalve.com)
 - j. NIBCO Incorporated. (www.nibco.com)
 - k. Powell Valves. (www.powellvalves.com)
 - l. Red-White Valve Corporation. (www.redwhitevalvecorp.com)
 - m. Stockham; Crane Energy Flow Solutions (www.cranecpe.com)
 - n. Sure Flow Equipment, Inc. (www.sureflowequipment.com)
 - o. 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.

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 following:
 - 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 following:
 - 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.
 - b. Body Material: ASTM A 536, ductile iron.
 - 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.
 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. 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.

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.
 3. Standard: MFMA-4.
 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.
 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 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.
 3. Clement Support Services.
 4. ERICO International Corporation.
 5. National Pipe Hanger 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.
 1. Properties: Non-staining, noncorrosive, and nongaseous.
 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.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- 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

SECTION 22 05 48
NOISE AND VIBRATION CONTROL FOR PLUMBING SYSTEMS

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

- A. American Association of State Highway Transportation Officials (AASHTO) Standard Specifications for Highway Bridges, Highway Bridge Specification, Table B: Requirements for Physical Properties of Bridge-Bearing Quality Neoprene.

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 1/2 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.

Equipment Type	On Grade Installation			Above Grade Installation		
	Base	Isolator	Defl.	Base	Isolator	Defl.
Base-Mounted Pumps & Compressors						
<i>5HP or greater</i>	B-3	M-3	1.0"	B-3	M-3	2.0"
<i>Less than 5HP</i>	--	M-2	0.3"	B-1	M-3	1.0"
Inline Pumps						
<i>5HP or greater</i>	B-3	M-3	1.0"	B-3	H-3	2.0"
<i>Less than 5HP</i>	--	M-2	0.3"	B-1	H-3	1.0"
Sump & Ejector Pumps	--	M-1	0.1"	--	M-1	0.1"
Water Heaters / Boilers	B-1	M-4	1.0"	B-1	M-4 / H-4	2.0"
Passive devices connected to rotating equipment (Expansion Tanks, Heat Exchangers, Deaerators, etc.)	--	M-1	0.1"	--	M-2	0.3"

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:

Motor Size	Minimum Thickness of Inertia Base
5 to 20 horsepower	6 inches
25 to 50 horsepower	8 inches
60 to 100 horsepower	10 inches
Greater than 100 horsepower	12 inches

- 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:

Device	Within 30ft. of Reciprocating Equipment or Within the Entirety of the Equipment Room (Whichever is Greater)			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		
	Flr/Clg	Wall	Defl.	Flr/Clg	Wall	Defl.
Piping (except where noted in 1.f below)						
<i>Greater than 1" diameter</i>	M-3/ H-3	W-1	1.0"	M-2/ H-2	W-1	0.3"
<i>1" diameter or less</i>	SD-1	SD-1	n/a	SD-1	SD-1	n/a
<i>In Vertical Shaft (>1" dia.)</i>	P-1/P-2	--	0.3"	P-1/P-2	--	0.3"
Pipe Supports at Pumps	M-3/ H-3	W-1	1.0"	M-2/ H-2	W-1	0.3"
Conduit (see section 260548)						

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 30ft 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:

Device	Size	Connector
Piping Connected to Reciprocating Equipment		
<i>Pumps (except as noted below), Condensing Units, Boilers, Air Handling Units</i>	< 2" diameter 2" to 14" diameter >14" diameter	FC-1 (single-sphere) FC-1 (twin-sphere) FC-1 (single sphere)
<i>Fan Coil Units, Fan-Powered Boxes</i>	All	FC-2
<i>Air Compressor Pumps</i>	All	FC-2
<i>Sewage Ejector Pumps</i>	All	Flexible coupling per pump supplier
Piping Connected to Passive Equipment		
<i>Heat Exchangers, Expansion Tanks, Glycol Tanks, Dearators, Reheat Coils</i>	< 2" diameter 2" to 14" diameter >14" diameter	FC-1 (single sphere) FC-1 FC-1 (single sphere)
<i>Air Compressor Tank</i>	All	FC-2
Piping crossing an AIJ or AIC below grade	All	FC-4

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:
 - 1. E90-97 – Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss through Building Partitions.
 - 2. E336-97 – Standard Test Method for Measurement of Airborne Sound Insulation in Buildings
 - 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):

125 Hz	250 Hz	500 Hz	1kHz	2kHz	4kHz	STC
15	19	21	28	33	37	26

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. 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.
 - 3. Background Color: White.
 - 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."
 4. Color: Yellow background with black lettering.

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.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label Color Schedule:
1. Low-Pressure, Compressed-Air Piping:
 - a. Background Color: Blue.
 - b. Letter Color: White.
 2. Domestic Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 3. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.

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:
 - a. Cold Water: 1-1/2 inches round.
 - b. Hot Water: 1-1/2 inches round.
 - c. Compressed Air: 1-1/2 inches round.
 - 2. Valve-Tag Color:
 - a. Cold Water: Natural.
 - b. Hot Water: Green.
 - c. Compressed Air: Blue.
 - 3. Letter Color:
 - a. Cold Water: White.
 - b. Hot Water: White.
 - 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.
 9. Mass loaded vinyl lagging for plumbing piping.

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. Supply and Drain Protective Shielding Guards: ICC A117.1.

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

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for 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. 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; Fiberglass 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

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 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.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 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:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - 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."
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
 - 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.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco 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:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - 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.
 5. Color: White.

2.6 SEALANTS

- A. Joint Sealants:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 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 C 1136, 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.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto 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.

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.
 - 4. Adhesion: 90 ounces force/inch in width.
 - 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.
 - 4. Cleanouts.

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-resistive 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. 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 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.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 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.

2. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.
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.
 - 2. Standard: ASSE 1079.
 - 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.
 - 3. Pressure Rating: 150 psig.
 - 4. Gasket: Neoprene or Phenolic.
 - 5. Bolt Sleeves: Phenolic or polyethylene.
 - 6. Washers: Phenolic with steel backing washers.
- 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.
 - 2. Standard: IAPMO PS 66.
 - 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.
 - 6. Lining: Inert and noncorrosive, propylene.

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. Join 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 uncealed 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.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 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.
 3. Hot-Water Circulation Piping, Balancing Duty: Calibrated, Memory-stop balancing valves.
 4. Drain Duty: Capped, Hose-end ball valves.
- 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 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.
3. Impeller: Plastic.
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.
 3. Enclosure: NEMA 250.
 4. Operation of Pump: On or off.
 5. Power Requirement: 24 V, ac.

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 tapings 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. Soil, Waste, and Vent Piping: 20-foot head of water.
 - 2. Waste, Force-Main Piping: 50 psig.

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.
 2. Standards: ASTM C 1277, ASTM C 1540, CISPI Designation 310-09, NSF Certified, and FM EN 1680.
 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. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
 2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- C. 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.

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).
 - 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
 - b. Standard: ASTM C 1460, NSF Certified.
 - 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.
 - b. Standard: AWWA C219.
 - 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 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

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- 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.

E. 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.

F. 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.
 2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- G. Underground, soil and waste piping NPS 15 and larger shall be the following:
 1. Cellular-core PVC pipe; PVC socket fittings; and solvent-cemented joints.
 2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

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.
 - 6. Miscellaneous sanitary drainage piping specialties.
 - 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

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- 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.
- B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

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:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 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:
 - a. Josam Company; Josam Div.
 - b. Oatey.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, 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:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, 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.
 - 3. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.
 - 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:
 - a. Josam Company; Josam Div.
 - 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:
 - a. Josam Company; Josam Div.
 - 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.
5. 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.
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.
 - 3. Burning: 6-lb/sq. ft., 0.0938-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.
- D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- 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-flashing 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.
 - b. Dallas Specialty & Mfg. Co.
 - c. Fernco Inc.
 - d. Ideal
 - e. Matco-Norca, Inc.
 - f. MIFAB, Inc.
 - g. Mission Rubber Company; a division of MCP Industries, Inc.
 - h. Stant.
 2. Standards: ASTM C 1277 and CISPI 310.
 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.
 - c. Dallas Specialty & Mfg. Co.
 - d. Ideal
 - e. MIFAB, Inc.
 - f. Mission Rubber Company; a division of MCP Industries, Inc.
 - g. Stant.
 - h. Tyler Pipe.
 2. Standards: ASTM C 1277 and ASTM C 1540.
 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.
- B. Galvanized Cast-Iron Drainage Fittings: ASME B16.12 threaded.
- C. Steel-Pipe Pressure Fittings:
 1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
 2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 3. Galvanized Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- 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.
 2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged-steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.

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.
 2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
 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:
 1. Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.
 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.
 - b. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings with dimensions matching AWWA C110/A21.10 ductile-iron pipe or AWWA C153/A21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.

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:
 - 1) Dallas Specialty & Mfg. Co.
 - 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:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 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:
 - 1) Cascade Waterworks Mfg. Co.
 - 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:
 - 1) Cascade Waterworks Mfg. Co.
 - 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

- A. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- 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.
 3. In Aboveground Force-Main Piping: Fitting-type 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.
 - 3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- 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.
 - 3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- 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.
 - 3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- 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.
3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

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
 - a. Josam Company.
 - b. Smith, Jay R. Mfg. Co.
 - 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.
 3. Body Material: Cast iron.
 4. Dimension of Body: Nominal 14-inch diameter.
 5. Combination Flashing Ring and Gravel Stop: Required.
 6. Outlet: Bottom.
 7. Extension Collars: Required.
 8. Underdeck Clamp: Required.
 9. Expansion Joint: 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.
 13. Vandal-Proof Dome: Not required.
 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
 - a. Josam Company.
 - b. Oatey.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.
 - 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.
 9. Top-Loading Classification: Medium Duty.
 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
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.
 - 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
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.
 - 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.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

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 assemblies.
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 thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.

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)
 - g. Zoeller Company. (www.zoeller.com)
 - 2. Description: Factory-assembled and -tested sump-pump unit.

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: Mechanical.
8. Motor: Hermetically sealed, 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 or Air filled.
9. Controls:
 - a. Enclosure: NEMA 250, Type 1.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
10. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. 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.
11. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
12. Guide-Rail Supports:
 - a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
 - 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.

- C. Capacities and Characteristics:
 - 1. Refer to equipment schedules:.

2.4 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.
- B. Motors for submersible pumps shall be hermetically sealed.

2.5 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.
 - 1. 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.
 - 3. Safety valves.
 - 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:
 - 1. Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.
 - 2. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

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:
 - a. Capitol Manufacturing Company.
 - 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:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. EPCO Sales, Inc.
 - d. Watts Water Technologies, Inc.; Water Products Div.
- 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.
 - 4. Milton Industries, Inc.
 - 5. Parker Hannifin Corp.; Fluid Connectors Group; Quick Coupling Div.
 - 6. Rectus Corp.
 - 7. Schrader-Bridgeport; Amflo Div.
 - 8. Schrader-Bridgeport/Standard Thomson.
 - 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.
1. Hose: Reinforced single- or double-wire-braid, CR-covered hose for compressed-air service.
 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.
 - 3. NPS 3/4: 84 inches with 3/8-inch rod.
 - 4. NPS 1: 96 inches with 3/8-inch rod.

5. NPS 1-1/4: 108 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.
 13. NPS 6: 20 feet with 5/8-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.
 - 3. Computer interface cabinet.

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.
 - 2. Motor Controllers: Full-voltage, combination magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
 - 3. Control Voltage: 120-V ac or less, using integral control power transformer.
 - 4. Motor Overload Protection: Overload relay in each phase.
 - 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)
 - 4. Gardner Denver, Inc. (www.gardnerdenver.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.quincycompressor.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.
 6. Power transformer.
 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. Automatic Drain Valves: Install on receivers, and dryers. Discharge condensate over nearest floor drain.

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:
 - 1. Commercial gas-fired, domestic-water heaters.
 - 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)
 - 2. Standard: ANSI Z21.13/CSA 4.9 for hot-water-supply boilers.
 - 3. Description: Packaged unit with boiler, storage tank, pump, piping, and controls.
 - 4. Boiler Construction: ASME code with 160-psig working-pressure rating for hot-water-boiler-type, domestic-water heater.
 - 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.
 - d. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, intermittent electronic-ignition system.
 - 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.
 - a. Construction: According to ASME Boiler and Pressure Vessel Code: Section VIII, steel with 150 psig working-pressure rating.
 - 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:
 - a. Anode Rods: Factory installed, magnesium.
 - 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. 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."
- F. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.
- G. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include pressure rating as required to match gas supply.
- H. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- 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.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
- J. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
- 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

- A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base.
 - 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.

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.
 - 6. Water closets.
 - 7. Urinals.
 - 8. Lavatories.
 - 9. Commercial sinks.
 - 10. Service sinks.
 - 11. Service basins.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- 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.
- I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

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.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- 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.
 - 2. Plastic Mop-Service Basins: ANSI Z124.6.
 - 3. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
 - 4. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 - 5. Stainless-Steel Commercial, Hand wash sinks: NSF 2 construction.
 - 6. Stainless-Steel Residential Sinks: ASME A112.19.3.
 - 7. Vitreous-China Fixtures: ASME A112.19.2M.
 - 8. Water-Closet, Flushometer Tank Trim: ASSE 1037.
- 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.
 - 2. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 - 3. Faucets: ASME A112.18.1.
 - 4. Hose-Connection Vacuum Breakers: ASSE 1011.
 - 5. Hose-Coupling Threads: ASME B1.20.7.
 - 6. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 7. NSF Potable-Water Materials: NSF 61.
 - 8. Pipe Threads: ASME B1.20.1.
 - 9. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 - 10. Supply Fittings: ASME A112.18.1.
 - 11. Brass Waste Fittings: ASME A112.18.2.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 - 1. Atmospheric Vacuum Breakers: ASSE 1001.
 - 2. Brass and Copper Supplies: ASME A112.18.1.
 - 3. Manual-Operation Flushometers: ASSE 1037.
 - 4. Plastic Tubular Fittings: ASTM F 409.
 - 5. Brass Waste Fittings: ASME A112.18.2.
 - 6. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Floor Drains: ASME A112.6.3.

2. Hose-Coupling Threads: ASME B1.20.7.
3. Hot-Water Dispensers: ASSE 1023 and UL 499.
4. Off-Floor Fixture Supports: ASME A112.6.1M.
5. Pipe Threads: ASME B1.20.1.
6. Plastic Toilet Seats: ANSI Z124.5.
7. Supply and Drain Protective Shielding Guards: ICC A117.1.

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.
 - 2. Accessible-Fixture Support: Include rectangular steel uprights.
- 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.
 - 2. Accessible-Fixture Support: Include rectangular steel uprights.
- 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

- A. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- 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 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.
 - c. Control-Valve Actuator: Paddle.
 - 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.
5. Control-Valve Actuator: Paddle.
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 specialties 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 covering 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 following:
 - a. Elkay Manufacturing Company (www.elkay.com)
 - 2. Support: ASME A112.6.1M, Type I water-cooler carrier.
 - 3. Capacities and Characteristics: See Schedule on Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual 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.
- 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. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Grout.
 - 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. Manufacturers 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, 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. 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:
 - 1. Hart Industries, International, Incorporated (www.hartindustries.com)
 - 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.
 - 3. Packaging: Premixed and factory packaged.

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.
- 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.
- E. 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.
- 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. 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.
 - 3. 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.
 - 4. PVC Non-pressure Piping: Join according to ASTM D 2855.

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 dielectric nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install HVAC 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 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 HVAC 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.

3.6 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:
 - 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. Defense Security Service Office of the Designated Approving Authority – Master System Security Plan (MSSP) Template for Peer-to-Peer Networks (June 2011, Version 3.0.).
 - 4. IEC 62443: Industrial Network and System Security.

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

System Description	Furnished By	Installed By	Wired/Piped By
Hot Water Boilers			
Manufacture supplied field installed controls	HVAC	HVAC	BAS
CSD-1 Emergency shutdown	HVAC	HVAC	BAS
120v power to boiler control panel	E	E	E
120v power to BAS panel	E	E	E
Manufacture control interlocks	HVAC	HVAC	BAS
120v power to chemical treatment control panel	E	E	E
Mixing valve(s)	BAS	HVAC	BAS
Thermowell(s)	BAS	HVAC	-
Temperature sensor(s)	BAS	BAS	BAS
Manual fill valve	HVAC	PLBG	PLBG
Chiller			
Manufacture supplied control panel	HVAC	HVAC	BAS
120v power to chiller control panel	E	E	E
Manufacture control interlocks	HVAC	HVAC	BAS
Control Isolation valve(s)	BAS	HVAC	BAS
Thermowell(s)	BAS	HVAC	-
Temperature sensor	BAS	BAS	BAS
Pressure transmitters	BAS	HVAC	BAS
Pressure transmitter taps	HVAC	HVAC	-
GPM Flow meter	HVAC	HVAC	BAS
Manual fill valve	HVAC	PLBG	PLBG
Hydronic Pumps			
GPM Flow meter	HVAC	HVAC	BAS
Pump differential pressure switch	BAS	BAS	BAS
Pump control relay/current sensor	BAS	BAS	BAS
Variable Frequency Drive: Power/Control	HVAC	E	E/BAS
Domestic Hot Water Heat Exchangers			
HW control valve	BAS	HVAC	BAS
Thermowell	BAS	PLBG	-
Temperature sensor	BAS	BAS	BAS

System Description	Furnished By	Installed By	Wired/Piped By
Air Handling Unit			
Control damper(s) at unit RA, OA, EA	BAS	HVAC	-
Control damper actuators at unit RA, OA, EA	BAS	BAS	BAS
Control damper(s) remote from unit.	BAS	HVAC	-
Control damper actuator(s) remote from unit	BAS	BAS	BAS
Isolation damper(s)	BAS	HVAC	-
Isolation damper actuator(s)	BAS	BAS	BAS
Cooling coil bypass damper	BAS	HVAC	-
Cooling coil bypass damper actuator	BAS	BAS	BAS
Unit smoke damper(s) & actuator(s)	M	HVAC	BAS
HW/CHW/Humidifier control valve(s)	BAS	PLBG	BAS
Temperature/humidity sensor(s)	BAS	BAS	BAS
Pressure transmitter	BAS	BAS	BAS
Air Flow Measuring Station(s)	BAS	HVAC	BAS
Differential pressure switch	BAS	BAS	BAS
Control relay/current sensor	BAS	BAS	BAS
Variable Frequency Drive(s): Power/Control	HVAC	E	E/BAS
Temperature low limit	BAS	BAS	BAS
Humidity high limit	BAS	BAS	BAS
Static pressure switch	BAS	BAS	BAS
120v power to DDC control panel	E	E	E
Duct smoke detector fan interlock	E	-	-
Duct smoke detector to fire alarm system	E	E	E
Fan Coil Air Terminal			
Air terminal unit controls	BAS	BAS	BAS
Temperature sensor	BAS	BAS	BAS
Hot water heating coil control valve	BAS	HVAC	BAS
Fan current sensor	BAS	BAS	BAS
Fan control relay	HVAC	HVAC	BAS
Control transformer	BAS	BAS	E
Fan	HVAC	HVAC	E
VAV Air Terminal			
VAV air terminal controls	BAS	BAS	BAS
Temperature sensor	BAS	BAS	BAS
Hot water heating coil control valve	BAS	HVAC	BAS
Hot Water Unit Heaters			
Thermostat or temperature sensor	BAS	BAS	BAS
Control valve	BAS	HVAC	BAS
Line voltage aquastat	BAS	BAS	BAS
Radiation			
Thermostat or temperature sensor	BAS	BAS	BAS
Control valve	BAS	HVAC	BAS

System Description	Furnished By	Installed By	Wired/Piped By
Exhaust Fan			
Control relay/current sensor	BAS	BAS	BAS
Control damper(s)	BAS	HVAC	-
Control damper actuator(s)	BAS	BAS	BAS
Power Roof Ventilators			
Control relay/current sensor	BAS	BAS	BAS
Control damper(s)	HVAC	HVAC	-
Control damper actuator(s)	HVAC	HVAC	BAS
Network			
LAN wiring to 1 st tier supervisory TCP's	D	D	D
BAS 2 nd tier (N2 Bus) communication wiring	BAS	BAS	BAS
Control Power			
120v power to DDC panels	E	E	E
120v power to VAV air terminal transformer panel	E	E	E
120v circuit breaker to DDC Panel	E	E	E
Control Wiring			
DDC panel input/output wiring	BAS	BAS	BAS
DDC panel to motor starter/VFD	BAS	BAS	BAS
24v power to dampers/valves	BAS	BAS	BAS
24v power to VAV air terminal	BAS	BAS	BAS
Humidifier			
Humidity sensor	BAS	BAS	BAS
Air flow proving switch	HVAC	HVAC	BAS
Control valve	BAS	PLBG	BAS
Jacket valve	HVAC	HVAC	HVAC
Smoke Damper			
Smoke damper(s) & actuator(s)	HVAC	HVAC	HVAC
120v power to smoke damper(s)	E	E	E
Fire alarm system interlock signal (soft)	E	-	-
Fire Damper			
Fire damper(s)	HVAC	HVAC	-
Combination Fire/Smoke Damper			
Combination fire/smoke damper(s)	HVAC	HVAC	-
Pneumatic actuator(s)	HVAC	HVAC	BAS
Electric actuator	HVAC	HVAC	E
120V to fire/smoke damper(s)	E	E	E
Fire alarm system interlock signal	E	-	-

System Description	Furnished By	Installed By	Wired/Piped By
Emergency Generator			
Package Diesel Engine Generator Set	E	E	E
120v power to day tank control panel	E	E	E
Day tank fuel level and transfer pump controls	E	E	E
Fuel piping to day tank	HVAC	HVAC	HVAC
Fuel piping; day tank to engine	HVAC	HVAC	HVAC
Day tank vent piping	HVAC	HVAC	HVAC
Day tank emergency vent cap	E	HVAC	HVAC
Fuel solenoid valve(s)	E	HVAC	E
Fuel transfer pump	E	E	-
Fuel transfer pump piping	-	-	HVAC
Fuel transfer pump wiring (power & control)	-	-	E
Fuel leak detection system	HVAC	HVAC	BAS
120v power for fuel leak detection panel	E	E	E
Ventilation Dampers	BAS	HVAC	BAS
Ventilation damper actuators	BAS	BAS	BAS
Damper, generator, interlock	E	E	E

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.
3. Building Automation System (BAS).
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. National Fire Protection Associations (NFPA).
2. Underwriter's Laboratories, Inc. (UL).
3. American National Standards Institute (ANSI).
4. American Society of Testing Materials (ASTM).
5. American Society of Mechanical Engineers (ASME).
6. American Welding Society Code (AWSC).
7. American Water Works Association (AWWA).
8. Manufacturers Standardization Society (MSS).
9. National Bureau of Standards (NBS).

- 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 Equivalentents and Substitutions".
- F. Contractor's Responsibility for Equivalentents and Substitutions:
1. Items submitted as a substitution to the Basis of Design or listed general equivalentents shall be identified as such and shall include a written request for substitution indicating the following:
 - a. Contract Price adjustment.
 - 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 equivalentent or substituted product, submit a comparison chart listing features, construction, performance and sizes of name product versus equivalentent or substituted product.
 5. Submittals for review of an equivalentent 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 equivalentency 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 Equivalentents and Substitutions: Where Contract Documents permits selection from general equivalentents, 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 equivalentent 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 equivalentents 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-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.
 - 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.
- E. Rotor: Random-wound, squirrel cage.
- 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: Conformance 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.
 - 9. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
 - 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.
 - 14. Vibration Withstand: Comply with NEMA ICS 61800-2.
 - 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 three 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.
1. Signal: Electrical.
- 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.
 3. Under- and overvoltage trips.
 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 overtemperature 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.
 8. Loss-of-phase protection.
 9. Reverse-phase protection.
 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.
 - 6. External fault.
- 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).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 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 the 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.
 - 1. Bypass Contactor: Load-break, IEC-rated contactor.
 - 2. Input and Output Isolating Contactors: Non-load-break, IEC-rated contactors.
 - 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. Reduced-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 running in the bypass mode.

4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer'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 motor 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 filters 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.
 - 2. Pilot Lights: Push to test.
 - 3. Selector Switches: Rotary type.
 - 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.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- E. Supplemental Digital Meters:
 - 1. Elapsed-time meter.
 - 2. Kilowatt meter.
 - 3. Kilowatt-hour 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.
 - 6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 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 \pm 1 Hz.
 - b. Minimum output frequency = 4 Hz \pm 1 Hz.
 - c. Control signal setpoint \pm 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

- A. Rubber Expansion Joints: ASTM F 1123, fabric-reinforced rubber with external control rods and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

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.
 - f. Mason Industries, Inc.; Mercer Rubber Co.
 - 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.
 5. End Connections: Full-faced, integral, steel flanges with steel retaining rings.
- 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. Adscos Manufacturing LLC. (www.adscosmfg.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.
 - 3. Washers: ASTM F 844, steel, plain, flat washers.
 - 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.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.
 - 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.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.

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:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 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:
 - 1. Smith, Jay R. Manufacturing. Company (www.jrsmith.com)
 - 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)
 - 3. Metraflex Company (The). (www.metraflex.com)
 - 4. Pipeline Seal and Insulator, Incorporated (www.pipeline Seal.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

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement 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:
 - a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6: 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 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:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - 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 surface 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.
 - c. Palmer Wahl Instrumentation Group.
 - d. Tel-Tru Manufacturing Company.
 - e. Trerice, H. O. Company
 - f. Weiss Instruments, Incorporated
 - g. Winters Instruments - U.S.
 - 2. Standard: ASME B40.200.
 - 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.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

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.
4. Case Form: Adjustable angle.
5. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
6. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
7. Display: 3/8-inch high LCD Digital.
8. Accuracy: Plus or minus 1 degrees F.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
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.
 - f. Miljoco Corporation.
 - 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.
- 2. Standard: ASME B40.100.
- 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.
- 8. Pointer: Dark-colored metal.
- 9. Window: Glass.
- 10. Ring: Stainless steel.
- 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
 - 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. 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 Fs 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:
 - a. Rotor: Non-metallic.
 - 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 minutes (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.
- B. Flowmeters for Heating, Hot-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.

END OF SECTION

SECTION 230523 GENERAL-DUTY VALVES 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. This Section includes the following general-duty valves:
 - 1. Copper-alloy ball valves.
 - 2. Ferrous-alloy butterfly valves.
 - 3. Bronze check valves.
 - 4. Steel spring check valves.
 - 5. Cast iron spring check valves
 - 6. Bronze globe 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:
 - a. Tyco International, Ltd.; Tyco Valves & Controls.
 - 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.
 2. Butterfly Valves, NPS 4 and Larger: Single-flange, 150-psig CWP rating, ferrous alloy, with EPDM liner.
 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.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
- 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.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- 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:
 - a. Allied Tube & Conduit. (www.alliedtube.com)
 - 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.wesanco.com)
 - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 3. Standard: MFMA-4.
 - 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.
 - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

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)
 - 2. Clement Support Services. (www.clementsupport.com)

3. ERICO International Corporation. (www.erico.com)
 4. National Pipe Hanger Corporation. (www.nationalpipehanger.com)
 5. PHS Industries, Inc. (www.phsind.com)
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc. (www.pipingtech.com)
 7. Piping Technology & Products, Inc. (www.pipingtech.com)
 8. Rilco Manufacturing Co., Inc. (www.rilcomfg.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.
 - 1. Properties: Non-staining, noncorrosive, and nongaseous.
 - 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.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- 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

SECTION 23 05 48
NOISE AND VIBRATION CONTROL FOR HVAC SYSTEMS

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

- A. American Association of State Highway Transportation Officials (AASHTO) Standard Specifications for Highway Bridges, Highway Bridge Specification, Table B: Requirements for Physical Properties of Bridge-Bearing Quality Neoprene.

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 1/2 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.

Equipment Type	On Grade Installation			Above Grade Installation		
	Base	Isolator	Defl.	Base	Isolator	Defl.
Air Handling Units						
<i>4,000cfm or greater</i>	B-1	M-3	1.0"	B-1	M-3 / H-3	2.0"

Equipment Type	On Grade Installation			Above Grade Installation		
	Base	Isolator	Defl.	Base	Isolator	Defl.
<i>Less than 4,000cfm</i>	B-1	M-1	0.1"	B-1	M-3 / H-3	1.0"
Roof-Mounted Air Handling Units, Packaged Rooftop Units, and Mushroom-Type Fans						
<i>4,000cfm or greater</i>	--	--	--	C-2	In base	2.0"
<i>Less than 4,000cfm</i>	--	--	--	C-1	In base	1.0"
Fans, Fan Coil Units, and Heat Pumps						
<i>4,000cfm or greater</i>	B-1	M-3	1.0"	B-1	M-3 / H-3	2.0"
<i>Less than 4,000cfm</i>	B-1	M-1	0.1"	B-1	M-3 / H-3	1.0"
Condensing Units	B-1	M-2	0.3"	B-1	M-3	2.0"
Motors (if motor base is separate from associated equipment)						
<i>5HP or greater</i>	B-1	M-2	0.3"	B-1	M-3 / H-3	2.0"
<i>Less than 5HP</i>	B-1	M-1	0.1"	B-1	M-3 / H-3	1.0"
Chillers						
<i>Reciprocating or Screw</i>	B-1	M-4	1.0"	B-1	M-4	2.5"
Boilers						
<i>Water Tube</i>	B-1	M-2	0.3"	B-1	M-4	1.5"
<i>Fire Tube</i>	B-1	M-3	1.0"	B-1	M-3	2.0"
Base-Mounted Pumps & Compressors						
<i>5HP or greater</i>	B-3	M-3	1.0"	B-3	M-3	2.0"
<i>Less than 5HP</i>	--	M-2	0.3"	B-1	M-3	1.0"
Inline Pumps						
<i>5HP or greater</i>	B-3	M-3	1.0"	B-3	H-3	2.0"
<i>Less than 5HP</i>	--	M-2	0.3"	B-1	H-3	1.0"
Passive devices connected to rotating equipment (Expansion Tanks, Heat Exchangers, Deaerators, etc.)	--	M-1	0.1"	--	M-2	0.3"

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:

Motor Size	Minimum Thickness of Inertia Base
5 to 20 horsepower	6 inches
25 to 50 horsepower	8 inches
60 to 100 horsepower	10 inches

- 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:

Device	Within 30ft. of Reciprocating Equipment or Within the Entirety of the Equipment Room (Whichever is Greater)			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		
	Flr/Clg	Wall	Defl.	Flr/Clg	Wall	Defl.
Ductwork	M-3/ H-3	H-3	1.5"	M-2/ H-2	H-2	0.3"
Piping (except where noted in 1.f below)						
<i>Greater than 1" diameter</i>	M-3/ H-3	H-3	1.0"	M-2/ H-2	W-1	0.3"
<i>1" diameter or less</i>	SD-1	W-1/ SD-1	n/a	SD-1	W-1/ SD-1	n/a
<i>In Vertical Shaft (>1" dia.)</i>	P-1/P-2	--	0.3"	P-1/P-2	--	0.3"

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:

Device	Size	Connector
Ductwork		
<i>Connections to all fans and equipment with integral fans</i>	All	FC-3
<i>Where ductwork crosses an AIJ or AIC with rigidly-mounted fire or fire/smoke dampers within the wall</i>	All	FC-3 (both sides of the damper)
Piping Connected to Reciprocating Equipment		
<i>Pumps (except as noted below), Chillers, Condensing Units, Boilers, Air Handling Units</i>	< 2" diameter 2" to 14" diameter >14" diameter	FC-1 (single-sphere) FC-1 FC-1 (single sphere)
<i>Fan Coil Units, Fan-Powered Boxes</i>	All	FC-2
<i>Air Compressor Pumps</i>	All	FC-2
<i>Sewage Ejector Pumps</i>	All	Flexible coupling per pump supplier
Piping Connected to Passive Equipment		
<i>Heat Exchangers, Expansion Tanks, Glycol Tanks, Dearators, Reheat Coils</i>	< 2" diameter 2" to 14" diameter >14" diameter	FC-1 (single sphere) FC-1 FC-1 (single sphere)

Device	Size	Connector
<i>Air Compressor Tank</i>	All	FC-2
Piping crossing an AIJ or AIC below grade	All	FC-4

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.
 - 3. Background Color: White.
 - 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.

2.1 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."
 4. Color: Yellow background with black lettering.

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 3/4" 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.
 - b. Letter Color: White.
 - 4. Condensate Piping:
 - a. Background Color: Blue.
 - b. Letter Color: White

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.
 - 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air 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:
 - a. Chilled Water: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round
 - 2. Valve-Tag Color:
 - a. Chilled Water: Natural.
 - b. Hot Water: Natural.
 - 3. Letter Color:
 - a. Chilled Water: Black.
 - 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.
- Q. AABC: Associated Air Balance Council.
- R. NEBB: National Environmental Balancing Bureau.
- S. TAB: Testing, adjusting, and balancing.
- T. TABB: Testing, Adjusting, and Balancing Bureau.
- U. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

- A. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- B. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- 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:
 - a. The Contract Documents examination report.
 - 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.
- D. TAB Report Forms: Use standard forms from 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.
- 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. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. 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.
 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.
 2. Motor horsepower rating.
 3. Motor rpm.
 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.
 8. Report date.
 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.
 6. Balancing stations.
 7. Position of balancing devices.
- 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.
 - 6. Lagging adhesives.
 - 7. Sealants.
 - 8. Factory-applied jackets.
 - 9. Field-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.

- b. Jacket Materials for Pipe: 12 inches long by NPS 2.
- 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:
 - a. Fibrex Insulations Incorporated; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000 Pipe Insulation.
 - d. Manson Insulation Incorporated; Alley-K.
 - e. 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:

- a. CertainTeed Corporation; CrimpWrap.
- b. Johns Manville; MicroFlex.
- c. Knauf Insulation; Pipe and Tank Insulation.
- d. Manson Insulation Incorporated; AK Flex.
- e. Owens Corning; Fiberglas Pipe and Tank Insulation.

K. Phenolic:

- 1. Products: Subject to compliance with requirements provide one of the following:
 - a. ITW Insulation Systems; Trymer Green. (www.itwinsulation.com)
 - b. Kingspan Tarec Industrial Insulation NV; Koolphen K. (www.kingspantarec.com)
 - c. Resolco International BV; Insul-phen. (www.resolco.com)
- 2. Thermal conductivity (k-value) at 75 degrees F is 0.15 Btu x in. /h x sq. ft. x degrees F or less.
- 3. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
- 4. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
- 5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- 6. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
 - a. Preformed Pipe Insulation: ASJ.

L. Polyisocyanurate: Unfaced, preformed, rigid cellular Polyisocyanurate material intended for use as thermal insulation.

- 1. Products:
 - a. Apache Products Company; ISO-25.
 - b. ITW Insulation Systems; Trymer 2000 XP.
 - c. Duna USA Incorporated; Corafoam.
 - d. 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.
- 6. Factory-Applied Jacket: Requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 - 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

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 1. Products:
 - a. Insulco, Division of MFS, Incorporated; Triple I.
 - b. P. K. Insulation Mfg. Company, Incorporated; Super-Stik.
 - c. Or Approved Equal²⁰
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 - 1. Products:
 - a. P. K. Insulation Mfg. Company, Incorporated; Thermal-V-Kote.
 - b. Vitcas²⁰
 - c. Or Approved Equal²⁰
- 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.
 - b. P. K. Insulation Mfg. Company, Incorporated; PK No. 127, and Quik-Cote.
 - 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; Aero Seal.
 - 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.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - 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:

- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-96. (www.idccorp.com)
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-33. (www.fosterproducts.com)
 - c. Or Approved Equal²⁰
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- 1. Products:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - 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.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - 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.
 - 3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
- 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.
 - d. Marathon Industries, Incorporated; 550.
 - 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.
 - 4. Color: White.

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-52.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
 - c. Marathon Industries, Incorporated; 130.
 - d. Mon-Eco Industries, Incorporated; 11-30.
 - e. Vimasco Corporation; 136.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
 - a. Service Temperature Range: Minus 50 to plus 180 degrees F.
 3. Color: White.

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.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
 - 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.
 - e. Vimasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.

D. Service Temperature Range: Minus 40 to plus 250 degrees F.

1. Color: Aluminum.

E. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company²⁰
 - c. Or Approved Equal²⁰
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.

F. Service Temperature Range: Minus 40 to plus 250 degrees F.

1. Color: White.

2.9 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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
2. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
3. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

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.
 - b. P.I.C. Plastics, Incorporated; FG Series.
 - 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.
 4. Adhesion: 90 ounces force/inch in width.
 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:
 - a. Ideal Tape Company, Incorporated, an American Biltrite Company; 370 White PVC tape.
 - b. Venture Tape; 1506R.

2. Width: 1-1/2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
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.
4. Adhesion: 100 ounces force/inch in width.
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.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

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 Equal²⁰
- 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.
 - 9. Bevel and seal insulation ends around manholes, Handholes, ASME stamps, and nameplates.
 - 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 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. 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.

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 manufacturers 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 INSTALLATION OF PHENOLIC INSULATION

- A. General Installation Requirements:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
- B. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of 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 services, secure laps with outward-clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, 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.
- C. 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 cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
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 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.

3.12 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.

3.13 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.

3.14 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.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- 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.

3.15 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.

3.16 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:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1-inches thick.
 - 4. Coil and Fan Housings, and duct silencer insulation.
 - a. Mineral-Fiber Board: 1.5 inches thick and 2-lb/cu. ft. nominal density.

3.17 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.

3.18 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:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1-inches thick.
 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 or NBR of suitable thickness to meet manufacturer's recommendations and energy code requirements.

3.19 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.

3.20 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

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 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
 11. I/O: Input/output.
 12. IP: Internet Protocol
 13. ISO: International Standards Organization
 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)
 9. Underwriters' Laboratories (UL) UL 864.

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 than 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, freezestat, 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.

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: One space temperature sensor cover plate with custom logo.
- 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: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 2. A pre-submittal review meeting with the Commissioning Authority to cover this item is required. Coordinate requirements with CxA directly.
- C. Software files will be submitted on fully labeled CDs 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.
 3. A pre-submittal review meeting with the Commissioning Authority to cover this item is required. Coordinate requirements with CxA directly.
- D. 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. Organize the packages by building. 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. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 3. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 4. Wiring Diagrams: Power, signal, and control wiring.
 5. Details of control panel faces, including controls, instruments, and labeling.
 6. Written description of sequence of operation.
 7. Schedule of dampers including size, leakage, and flow characteristics.
 8. Schedule of valves including flow characteristics.
 9. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 10. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 11. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.

- b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. Points list.
12. A pre-submittal review meeting with the Commissioning Authority to cover this item is required. Coordinate requirements with CxA directly.
- E. Submittals Prior To Construction
- 1. A pre-submittal review meeting with the Commissioning Authority to cover this item is required. Coordinate requirements with CxA directly.
 - 2. Shop Drawings
 - a. System Architecture Design Diagram
 - 1) This is a riser diagram that shall show the IP layer and all of the field bus layers.
 - 2) 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.
 - 3) 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.
 - 4) The physical relationship of one component to another component will reflect the proposed installation.
 - 5) This diagram shall not include power supplies, sensors or end devices.
 - b. Layout Design Drawing for each control panel:
 - 1) The layout drawing will be to scale with devices shown in their proposed positions.
 - 2) Control devices will be identified by name.
 - 3) Terminal strips and wire channels will be shown.
 - 4) Control transformers will be shown.
 - 5) 120 VAC receptacles will be shown.
 - 6) IP connection points will be shown.
 - c. Wiring Design Diagram for each control panel.
 - 1) 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.
 - 2) 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.
 - 3) If shielded communication wiring is used, the grounding of the shield will be shown.
 - 4) 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.
 - d. 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.
 - e. Installation Design Detail for each I/O device.
 - 1) A drawing of the wiring details for each sensor and/or end device.
 - 2) For devices with multiple quantities, a standard detail may be submitted.
 - f. A System Flow Design Diagram for each controlled system.
 - 1) A two dimensional cross sectional diagram showing key components such as fans, coils, dampers, valves, pump, etc.
 - 2) 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.
 - 3) A legend will be provided for all symbols used.
 - 3. Data
 - a. BACnet Compliance Documentation:

- 1) 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:
 - (a) BACnet protocol revision
 - (b) Applications software and firmware revision
 - (c) Vendor and BACnet object description
 - (d) BIBBs supported by the device
 - (e) The standardized BACnet device profile to which the device conforms
 - (f) The non-standardized BACnet device application services
 - (g) A list of all standard and proprietary object types that are supported
 - (h) For each object type that is supported, the University requires the following:
 - (i) Optional properties that are supported with the device or BACnet server
 - (ii) A list of properties that can be written using BACnet services
 - (iii) Any object that can be dynamically created or deleted using BACnet services
 - (iv) Any restrictions in the data value range for properties
 - (i) Data link layer options supported
 - (j) Device address binding (necessary for two-way communication with MS/TP devices)
 - (k) Networking options (BBMD, MS/TP)
 - (l) Character sets supported
 - (m) Segmented requests or responses supported
- b. Direct Digital Control System Hardware Technical Data.
 - 1) A complete bill of materials of equipment to be used indicating quantity, manufacturer, and model number.
 - 2) 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.
 - 3) This requirement applies to:
 - (a) Controllers
 - (b) Transducers/Transmitters
 - (c) Sensors
 - (d) Actuators
 - (e) Valves
 - (f) Relays and Switches
 - (g) Control Panels
 - (h) Power Supplies
 - (i) Batteries
 - (j) Operator Interface Equipment
- c. 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.
- d. Sequence of Control: A sequence of control for each system being controlled. Include the following as a minimum.
 - 1) Process control sequence for each end device.
 - 2) Supervisory logic sequence of control for each system.
 - 3) The impact of each global application program on the sequence of control (Example: Demand Control).
 - 4) A list of all physical inputs and outputs associated with each sequence.
 - 5) Within the sequence of control, all application parameters that are to be user adjustable from an OWS will be annotated with (adj.) after the name of the parameter. This will include set points, reset schedule parameters, calibration offsets, timer settings, control loop parameters such as gain, integral time constant, sample rates, differentials, etc.

- 6) Points that will be subject to manual control from an operator workstation.
- 7) A list of all alarm points, a description of the alarm and a description of the alarm criteria.
- e. 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.
- F. Submittals during construction:
 - 1. A pre-submittal review meeting with the Commissioning Authority to cover this item is required. Coordinate requirements with CxA directly.
 - 2. Training manuals for each Training Course:
 - a. Submit the following six weeks in advance of the training:
 - 1) List of training objectives.
 - 2) Outline of the course with time allocations per topic.
 - 3) Training presentation material (slides, word documents, etc.).
 - 4) Copy of training reference material (product manuals to be used, etc.).
 - 5) Schematic of the training equipment to be used with model numbers on each component.
 - 6) A description of the measurement devices to measure training effectiveness (quizzes, programming exercises, course exam).
 - 7) Instructor's name and resume with an emphasis on experience in presenting training programs.
 - 3. Startup testing plan: Submit a start up testing plan for each unique system.
 - a. The purpose of a startup test is to demonstrate the completeness of the physical tasks associated with installation and the performance of the components.
 - b. 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.
 - c. Required elements of the startup testing include:
 - 1) Measurement of voltage sources, primary and secondary.
 - 2) Verification of proper controller power wiring.
 - 3) Verification of component inventory when compared to the submittals.
 - 4) Verification of labeling on components and wiring.
 - 5) Verification of connection integrity and quality (loose strands and tight connections).
 - 6) Verification of bus topology, grounding of shields and installation of termination devices.
 - 7) Verification of point checkout.
 - (a) Each I/O device is landed per the submittals and functions per the sequence of control.
 - (b) Analog sensors are properly scaled and a value is reported.
 - (c) Binary sensors have the correct normal position and the state is correctly reported.
 - (d) Analog outputs have the correct normal position and move full stroke when so commanded.
 - (i) 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.
 - (e) Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
 - 8) Documentation of analog sensor calibration (measured value, reported value and calculated offset).
 - 9) Documentation of loop tuning (sample rate, gain and integral time constant).
 - d. Submit at least two weeks prior to equipment startup.
 - 4. Startup testing report.
 - a. Startup testing reports will be submitted on a per system basis.

- b. Startup testing reports will be the documented results of the executed startup testing plans.
- 5. Graphic Pages: Submit a sample graphic page for each type of page described in the specification section on graphic pages.

G. Submittals after Construction

- 1. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as "As-Built". As-Built drawings will each be stamped "As-Built" and have the as-built date on them. The As-Built drawings will contain at a minimum:
 - a. System architecture drawing.
 - b. Detailed drawings for each piece of controlled and monitored equipment
 - 1) Layout drawing for each control panel.
 - 2) Wiring diagram for each control panel.
 - 3) Wiring diagram for individual components.
 - 4) Point lists
 - 5) Room Schedules
 - 6) Sequence of operation
 - 7) Hardware with part number information
 - 8) System flow diagram for each controlled system.
 - c. 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.
 - d. Binding map.
- 2. Operation and Maintenance Manuals:
 - a. The controls contractor will provide one electronic (PDF) copy and three (3) bound copies of Operation and Maintenance Manuals.
 - b. Deliver manuals to the University project manager.
 - c. Manuals will be bound in heavy-duty, vinyl-covered, three-post, loose-leaf binders, permanently labeled on front and spine of each binder.
 - d. Arrange the manuals according to specification section numbers used in the Project Manual; include a table of contents that identifies the responsible installing contractor, contact person, and telephone number with area code and thumb tab index sheets.
 - e. Provide pocket folders for folded sheet information.
 - f. Maintenance and Operating Manual will include the following type of information:
 - 1) One copy of the executed Certificate(s) of Substantial Completion. This document will be used to communicate to all necessary University personnel the starting date of the one-year Warranty period.
 - 2) Signed record copy of bonds, guarantees, and warranties required by the Contract Documents.
 - 3) Manufacturer's required preventative maintenance inspections, testing, service, lubrication, maintenance instructions, and schedules.
 - 4) Parts lists and local service organization.
 - 5) As-built wiring and piping diagrams.
 - 6) System architecture diagram for components within the building annotated with specific location information.
 - 7) As-built drawing for each control panel.
 - 8) As-built wiring design diagram for each control panel.
 - 9) As-built wiring design diagram for all components.
 - 10) Installation design details for each I/O device.
 - 11) As-built system flow diagram for each system.
 - 12) Sequence of control for each system.
 - 13) Room schedules.
 - 14) Binding map for the building.
 - 15) Product data sheet for each component.
 - 16) Installation data sheet for each component.
 - 17) Other information required by the Specifications.
 - g. Instruct University personnel in the use of Maintenance and Operating Manuals.
- 3. Software

- a. Submit a copy of all software installed on the servers and workstations.
 - b. Submit all licensing information for all software installed on the servers and workstations.
 - c. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
 - d. Submit all licensing information for all of the software used to execute the project.
 - e. Software revisions will be as installed at the time of the system acceptance.
4. Firmware Files
- a. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.
 - b. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
 - c. Submit a copy of all application files that were created during the execution of the project.
 - d. Submit a copy of all graphic page files created during the execution of the project.
 - e. Submit a copy of all secondary graphic files such as bitmaps, jpegs, etc. that were used in the creation of the graphic pages.
- H. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- I. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
- J. Samples for Verification: For each color required, of each type of thermostat or sensor cover.
- K. 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.
- L. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- M. Field quality-control test reports.
- N. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
- 1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 - 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 5. Calibration records and list of set points.
- O. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- P. 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.
- Q. Provide necessary non-disclosure and license agreements for required software. Energy Management will receive software licenses, the original copies of software loaded into the system, and back-ups of system databases and programs on CDs. Original software and documentation will be delivered to Facilities Management. During construction the contractor will maintain CD copies of data files, application programs, and system software.
- R. Two copies of software and hardware needed to configure control devices will be provided to the Owner at the completion of the project. This includes software tools, cabling, disks, etc. needed to program, configure, and maintain building and unit level DDC devices and networking hardware provided as part of the project.
- S. 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.

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 "Intrusion Detection" to achieve compatibility with equipment that interfaces with that system and with building master clock.
- K. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.
- L. Coordinate equipment with Division 27 Section "Clock Systems" to achieve compatibility with equipment that interfaces with that system.
- M. Coordinate equipment with Division 28 Section "PLC Electronic Detention Monitoring and Control Systems" to achieve compatibility with equipment that interfaces with that system.

- N. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.
- O. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- P. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- Q. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
- R. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- S. 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 Niagara 4 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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSTALLERS

- A. Installers: Subject to compliance with requirements, automatic control systems will be installed by a vendor approved by University.
 1. TBD: Metro Mechanical Contractors controls.

2.3 CONTROL SYSTEM

- A. Manufacturers:
 1. Johnson Controls
 2. Trane Controls
- B. 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.

- C. Control system shall include the following:
 - 1. Building intrusion detection system specified in Division 28 Section "Intrusion Detection."
 - 2. Building lighting control system specified in Division 26 Section "Network Lighting Controls."
 - 3. Fire alarm system specified in Division 28 Section "Fire Detection and Alarm."

2.4 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.

2.5 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.

2.6 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 MPS communication rates.

2.7 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.

2.8 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.
 - 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 - 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.
 - 2. Maximum response time of 10 nanoseconds.
 - 3. Minimum transverse-mode noise attenuation of 65 dB.
 - 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.9 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 a Windows 7 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.

2.10 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 of 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.

2.11 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.

2.12 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.

2.13 DDC RESIDENT SOFTWARE FEATURES

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 - e. It will be possible to schedule events up to one year in advance.
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 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.
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2.14 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.

2.15 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.
 - 3. Digital Inputs: Two dry contacts.
 - 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.
 - 3. Measurement Resolution: Plus or minus 4 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.

2.16 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-linearities 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 $\pm 0.10^{\circ}\text{F}$. over the process temperature range.
- F. Space Sensors and Transmitters:
 - 1. Manufacturers:
 - a. Basis of Design: Veris Industries
 - b. Automation Components, Inc. (ACI)
 - c. Johnson Controls Incorporated
 - d. Basis of Design: Kele Incorporated
 - e. Mamac Systems
 - f. Schneider Electric
 - g. Siemens Building Technologies Incorporated
 - 2. All space sensors and transmitters shall be BACnet-compliant
 - 3. Space, Humidity and CO2 Sensors may be combined if performance requirements met.
 - 4. Space Temperature Sensors
 - a. S1 Space Temperature Sensor – Where noted on plans. **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. S2 Space Temperature Sensor – Corridors, Classrooms, Studios. **WHITE**
 - 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) Port: Plug-in portable-operators terminal port; located on the bottom of the cover.
 - c. S3 Space Temperature Sensor – Theater, Rehearsal Studio T004. **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.
- d. T1 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.
- e. T2 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.
- f. T3 Space Temperature Sensor – Wireless Locations. **WIRELESS, WHITE, OCCUPANCY OVERRIDE**
 - 1) Accuracy: 0.3 deg. C
 - 2) Range: 50 to 95 deg F.
 - 3) Platinum RTD
 - 4) Wireless
 - 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) Set-Point Adjustment: Warmer/Cooler control.
 - 7) Set-Point Indication: Concealed
 - 8) Override Button: allows the occupant to change the occupied control schedule during the unoccupied cycle for a predetermined period of time.
 - 9) Port: Plug-in portable-operators terminal port; located on the bottom of the cover.
 - 10) Provide all necessary programming, gateways and accessories for wireless sensor.
 - 11) After location confirmed by owner’s representative, secure wireless sensor to location indicated.
- 5. 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.
6. H2 Space Humidity Sensors
- a. Space Humidity Sensor – **BRUSHED STAINLESS STEEL**
 - 1) Accuracy: 2% at 50% RH and 70 deg F.
 - 2) Relative Humidity Range: Zero to 100 percent.
 - 3) Wire: Manufacturer’s standard cable assembly
 - 4) 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.
 - 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.
 - b. H3 Space Humidity Sensor – Theater, Rehearsal Studio T004 **BLACK, 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, black 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.
7. Space CO2 Sensors
- a. Space CO2 Sensor – All Spaces except Theater and Rehearsal Studio T004. **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 – Theater and Rehearsal Studio T004. **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.
3. Acceptable Manufacturers: Veris, Senva, BAPI, Vaisala.

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. 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
 - f. TCS/Basys Controls.
 - g. Vaisala.
 - h. Veris Industries
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.
- 3) Acceptable Manufacturers: Veris, Senva, Setra.

J. 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.
- K. 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.
- L. 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.
 3. Acceptable Manufacturer: Senva, Veris.
- M. 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.
- N. 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.
- O. 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.
- P. 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.
- Q. 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.
- R. 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.
 2. Maximum response time of 10 nanoseconds.
 3. Minimum transverse-mode noise attenuation of 65 dB.
 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.
- S. 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.
- T. All temperature transmitters, flow transmitters and pressure differential transmitters shall have a digital indication of the sensed variable.
- U. Daylight sensor: Indoor ambient light sensor suitable for daylight harvesting – Exact Logic EXL01020 or approved equal. Unit shall read 0-500 foot candle of indoor ambient light and provide signal directly to BAS system through 0-10v signal. Ceiling mounted sensor with single mounting hole and hardware with cable connection. Paint sensor ring to match installed ceiling. Calibrate light level readings with field conditions and align with BAS signal.

2.17 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.
 2. Casing: 16 gauge G90 galvanized-steel frame.
 3. Flow Straightener: Aluminum honeycomb, 3/4-inch parallel cell, 3 inches deep.
 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”, hermitically 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.

4. Sensor Distribution: Equal area.
 5. Airflow Sensor Accuracy: $\pm 2\%$ of reading
 6. Calibrated Range: 0-10000 FPM
 7. Temperature Sensor Accuracy: $\pm 0.15^\circ\text{F}$
 8. Temperature: -20°F to $+160^\circ\text{F}$
 9. Relative Humidity: 0 to 99% (non-condensing)
- D. Fan Array Airflow Station: Thermal dispersion type station measuring temperature and air flow.
1. Manufacturers:
 - a. Ebtron model GTx108-F/An
 - b. Air Monitor Corporation
 - c. Or Approved Equal
 2. Sensing Manifold: Multi-point "bead- in-glass", hermitically 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 eight 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: Forward mount, 1 probe per fan inlet. Independently wired sensors.
 4. Sensor Distribution: Equal area.
 5. Airflow Sensor Accuracy: $\pm 2\%$ of reading
 6. Calibrated Range: 0-10000 FPM
 7. Temperature Sensor Accuracy: $\pm 0.15^\circ\text{F}$
 8. Temperature: -20°F to $+160^\circ\text{F}$
 9. Relative Humidity: 0 to 99% (non-condensing)
- E. 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.
 4. Sensor Distribution: Equal area.
 5. Airflow Sensor Accuracy: $\pm 2\%$ of reading
 6. Calibrated Range: 0-5000 FPM
 7. Temperature Sensor Accuracy: $\pm 0.15^\circ\text{F}$
 8. Temperature: -20°F to $+140^\circ\text{F}$
 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
- F. 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: $\pm 2\%$ of reading
 - 7. Calibrated Range: 0-3000 FPM
 - 8. Temperature Sensor Accuracy: $\pm 0.15^\circ\text{F}$
 - 9. Temperature: -20°F to $+140^\circ\text{F}$
 - 10. Relative Humidity: 0 to 99% (non-condensing)
 - 11. Round Duct Size Limits: minimum 4 in. dia. to maximum 16 in. dia.
- G. Integral airflow monitoring dampers
- a. Manufacturers: 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.

2.18 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 are: Belimo ONLY.

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.
12. Acceptable Manufacturer: Belimo ONLY.

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.
12. Acceptable Manufacturer: Belimo ONLY.

F. 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:
 - a. Manufacturers:
 - 1) Belimo Aircontrols (USA), Inc. (PICCV) or approved equal.
 - 2) Hays Fluid Controls
 - 3) Or Approved Equal
 - b. The modulating control valves shall be pressure independent.
 - c. 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.
 - d. Provide means for pressure differential measurement either across orifice or valve to be used for flow verification.
 - e. 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.
 - f. Combination of actuator and valve shall provide a minimum close-off pressure rating of 200 PSI.
 - g. The control valve shall require no maintenance and shall not include replaceable cartridges.

- h. 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.
 - i. 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.
 - j. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
 - k. 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 (1/2" - 2"):
- a. Manufacturers:
 - 1) Belimo Aircontrols (USA), Inc. (CCV) or approved equal.
 - 2) Hays Fluid Controls
 - 3) Or Approved Equal
 - b. The modulating control valves shall be pressure dependent.
 - c. The control valves shall accurately control the flow from 0 to 100% full rated flow with an equal percentage flow characteristic.
 - d. 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.
 - e. Combination of actuator and valve shall provide a minimum close-off pressure rating of 200 PSI and 50 PSI differential.
 - f. The control valve shall require no maintenance and shall not include replaceable cartridges.
 - g. 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.
 - h. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
 - i. 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 (2-1/2" - 3"):
- a. Manufacturers:
 - 1) Belimo Aircontrols (USA), Inc. (CCV) or approved equal.
 - 2) Hays Fluid Controls
 - 3) Or Approved Equal
 - b. The modulating control valves shall be pressure dependent.
 - c. The control valves shall accurately control the flow from 0 to 100% full rated flow with an equal percentage flow characteristic.
 - d. 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 O-rings, dual EPDM lubricated O-rings at stem and stainless steel characterizing disc.
 - e. Combination of actuator and valve shall provide a minimum close-off pressure rating of 100 PSI and 50 PSI differential.
 - f. The control valve shall require no maintenance and shall not include replaceable cartridges.
 - g. 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.
 - h. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.

- i. 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. Manufacturers:
 - 1) Belimo Aircontrols (USA), Inc. (HD) or approved equal.
 - 2) Hays Fluid Controls
 - 3) Or Approved Equal
 - b. The on/off control valves shall be pressure dependent.
 - c. Ductile iron body, ANSI 125 class rated at 250 F, stainless steel disc and shaft, EDPM seats and O-rings,
 - d. Combination of actuator and valve shall provide a minimum close-off pressure rating of 200 PSI.
 - 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.
7. Pressure Dependent High Temperature Characterized Ball Control Valves:
- a. Manufacturers:
 - 1) Belimo Aircontrols (USA), Inc. (B2HT) or approved equal.
 - b. The modulating control valves (can be used as on/off per application schedule) shall be pressure dependent.
 - c. The control valves shall accurately control the flow from 0 to 100% full rated flow with an equal percentage flow characteristic.
 - d. Forged brass body, rated at no less than 400 PSI and 260 F water and 250 F steam, stainless steel ball and stem, female NPT union ends, Teflon PTFE seats, and Viton seat O-rings, dual EPDM lubricated O-rings at stem and TEFZEL characterizing disc.
 - e. Maximum inlet steam pressure 15 PSI.
 - f. Combination of actuator and valve shall provide a minimum close-off pressure rating of 200 PSI.
 - g. The control valve shall require no maintenance and shall not include replaceable cartridges.
 - 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 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.
8. 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
- 9.

2.19 DAMPERS

- A. Manufacturers: 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
 4. Honeywell, Incorporated; Home & Building Control.
 5. Johnson Controls, Incorporated; Controls Group.
 6. Ruskin Manufacturing Company
 7. Siemens Building Technologies
 8. T.A.C, a division of Schneider Electric
 9. T.A. Morrison & Co. Inc.
- B. Construction:
 1. Frames: Extruded aluminum hat channels, 0.125-in. minimum thickness.
 2. Blades: Extruded aluminum airfoil type, 6-inch maximum blade width.
 3. Hardware: Molded synthetic bearings. Zinc plated steel axles, linkage brackets, connecting rods, and mounting bolts.
 4. Seals: Flexible extruded silicone side seals and blade gaskets.
 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.

2.20 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.

2.21 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 ($\pm 10\%$), 47-63 Hz input voltage
 - b. Din-rail mounted
6. Manufacturer: Contemporary Controls used as basis of design manufacturer.

2.22 NETWORK SWITCH

- A. 10/100/1000BaseT Ethernet ports
- B. Power Over Ethernet (PoE) IEEE802.3af compliant (minimum)
- C. Managed layer 3 (minimum) network switch
- D. Network switch must be meet the most stringent certification requirements of all network-connected components within the Audio/Video system.
- E. Manufacturers:
 1. Brocade
 2. Cisco
 3. Extreme Networks
 4. IFS/GE

2.23 DOMESTIC WATER METERS

- A. Manufacturers: 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.

2.24 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

2.25 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/EAI 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."

2.26 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).

2.27 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 lamicoid 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 UniversityUniversity prior to installation.

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 neVICES 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 or General Contractor.

3.3 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. 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.
- G. 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.
- H. 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.
- I. Install a minimum of one "unitary controller" in each mechanical equipment room.
- J. 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.
- K. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- L. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- M. Install fan inlet air flow measuring stations according to the manufacturer's instructions.
- N. Install duct mounted air flow measuring stations according to the manufacturer's instructions. Comply with manufactures mounting requirements to achieve specified instrument accuracy.
- O. Install outside air static pressure probe according to the manufactures instructions.
- P. Connect end switches on smoke and combination fire/smoke dampers to BAS.
- Q. Install electronic and fiber-optic cables 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. Size damper actuators to operate the related control damper(s) with sufficient reserve power to provide smooth modulating action or two-position action.
 - 2. Actuators shall also be sized for proper speed of response at the velocity and pressure conditions to which the control damper is subject.
 - 3. Shall produce sufficient torque to close off against the maximum system pressures encountered.
 - 4. Shall produce sufficient torque to close off against the fan shutoff pressure as a minimum.

5. 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.
6. 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 IDENTIFICATION

- A. All identification shall be reviewed and approved with UniversityUniversity 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."

3.7 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Comply with all Division 26 Installation Requirements.
- B. Refer to Mechanical Electrical Coordination Schedules for additional details on electrical information, disconnects, starters, controls, devices, interlocks and accessories.
- C. Provide low voltage interlock wiring between supply and exhaust fans, electrical wiring for relays for temperature and pressure indication.
- D. 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.
- E. Provide all other wiring required for the complete operation of the specified systems.

- F. Where required install all wiring raceway systems complying with the requirements of the National Electrical Code. All required conduit shall be installed in EMT.
- G. 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.
- H. 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.
- I. LonWorks Network Communication Requirements:
 - 1. LonWorks network communication shall be via channels consisting of a 22 AWG unshielded twisted pair in compliance with manufactures recommendations for LonTalk communications.
 - 2. Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.
 - 3. There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring.
- 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.

3.8 ALARMS

- A. The completed system must be capable of transmitting fire alarms, emergency signals and building control points from the selected vendors systems to the MLWS. 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

3.9 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 as indicated below:

1. UPS shall maintain full operation for a period no less than 4 hours.
- E. 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.

3.10 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. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
- S. Mount transducers in a location accessible for service without the use of ladders or special equipment to the maximum extent possible.
- T. 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.
- U. 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.

3.11 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.
 2. Adjust the flow switch in accordance with the manufacturer's instructions.

3.12 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 $\pm 1/8$ -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 uses in determining valve type shall not be line size but valve size based on pressure drop and CV.
2. Air Terminal Unit Valves
 - a. Belimo B2 series 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) Belimo PICCV series pressure independent characterized control valves
 - 2) Fail Position: Fail-in-place (FIP)
 - b. Heating Hot Water - Preheat Position
 - 1) Belimo (1/2"-3") CCV pressure dependent characterized control valves and Belimo (>4") butterfly pressure dependent control valves
 - 2) Fail Position: Spring return fail open
 - c. Heating Hot Water – Heating / Reheat Position
 - 1) Belimo (1/2"-3") CCV pressure dependent characterized control valves and Belimo (>4") butterfly pressure dependent control valves
 - 2) Fail Position: Fail-in-place (FIP)
4. Steam Valves
 - a. Steam Heat Exchanger Valves
 - 1) Belimo (1" and smaller") High Temperature Characterized Ball Control Valves and Belimo (1-1/2" and larger") high performance characterized V-port ball control valves
 - 2) Normal Position: Normally closed (NC)
 - 3) Fail Position: Spring Return fail close
5. Boiler Valves
 - a. Boiler Control Valves
 - 1) Belimo (1/2"-3") CCV pressure dependent characterized control valves and Belimo (>4") butterfly pressure dependent control valves
 - 2) Fail Position: Spring return fail open
6. 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.
7. Valves sizes shall be no less than 2 nominal sizes of the installed pipe size.
8. Two-position valves shall be line size. Pressure Independent Control Valve Selection Commentary
 - 1) There are three criteria to consider when selecting Pressure Independent Control Valves: The brass valve body maximum flow rate
 - (b) The programmed flow rate of the actuator.

- (c) 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.
 - 2) 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.
 - 3) 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.
- b. 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.

3.13 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.

3.14 ACCESS DOORS

- A. Mechanical Contractor shall provide access doors or other approved means of access through ducts for service to control equipment.

3.15 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 UniversityUniversity 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 or 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 compiled 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 UniversityUniversity 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.

3.16 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 UniversityUniversity 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.

3.17 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.
 2. Energy recovery 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.

3.18 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

3.19 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. All external transport data shall be routed through encrypted channels with 2048-bit secure sockets layer (SSL).
- C. 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.

- D. 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.
- E. Set unique, cryptographically strong passwords for administrator and user accounts. Default passwords must be changed before systems are connected to the Owner's network.
- F. Collect only the data that is necessary for analytics and optimization.
- G. 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. Defense Security Service Office of the Designated Approving Authority – Master System Security Plan (MSSP) Template for Peer-to-Peer Networks (June 2011, Version 3.0).

3.20 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.

3.21 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 set points 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.

3.22 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.

3.23 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.

3.24 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 the 2002 EDITION of 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 than 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.

3.25 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.

END OF SECTION



WAYNE STATE UNIVERSITY

Facilities Management System Network

SUMMARY

The intent of this Building Technologies standard is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate industry standard open communication protocols into one interoperable Building Management System (BMS) and to assure consistency across all Building Automation projects commissioned by Wayne State University (WSU) Facilities Planning and Management (FP&M).

- FPM projects, as described herein, will include all labor, material, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and a Facilities Management Control System (FMCS), utilizing Direct Digital Controls (DDC).
- All labor, material, equipment, and software required to meet the functional intent of this standard not specifically referred to herein, or on plans/submittals, will be provided without additional cost to the owner
- Wayne State University shall be named license holder of all software associated with any and all incremental work on projects.
- Contractors shall provide a unique username and password with unlimited/unrestricted administrative access on all installed devices and associated software to the Master Systems Integrator (MSI) and the WSU FP&M team.

BASIS OF DESIGN

Master Systems Integrator

- Wayne State University (WSU) Facilities Planning and Management (FP&M) shall oversee the role of the Master Systems Integrator (MSI) as performed by Siemens Industry, Inc. All contracts for Systems Integration, if needed, shall be at the discretion of WSU FP&M.

Siemens Desigo CC v3.0 SR2 Building Management System (BMS)

- 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.
- The Desigo CC software is installed on application servers located in WSU Facilities Operations & Maintenance Service Center. Access to Desigo CC is distributed to WSU Building Engineers by Facilities Operations & Management through one of three client configurations: Desigo CC Thick Client, Desigo CC Web Client, and or the Desigo CC Click Once Client.
- 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:
 - Calendar functions
 - Scheduling
 - Trending
 - Alarm monitoring and routing
 - Integration of BACnet, MODBUS, OPC-DA, and SNMP controller data
 - Network management for BACnet based devices



REQUIREMENTS

BACnet Interoperability

BACnet interoperability refers to the ability to integrate BACnet products made by different manufacturers into a single system.

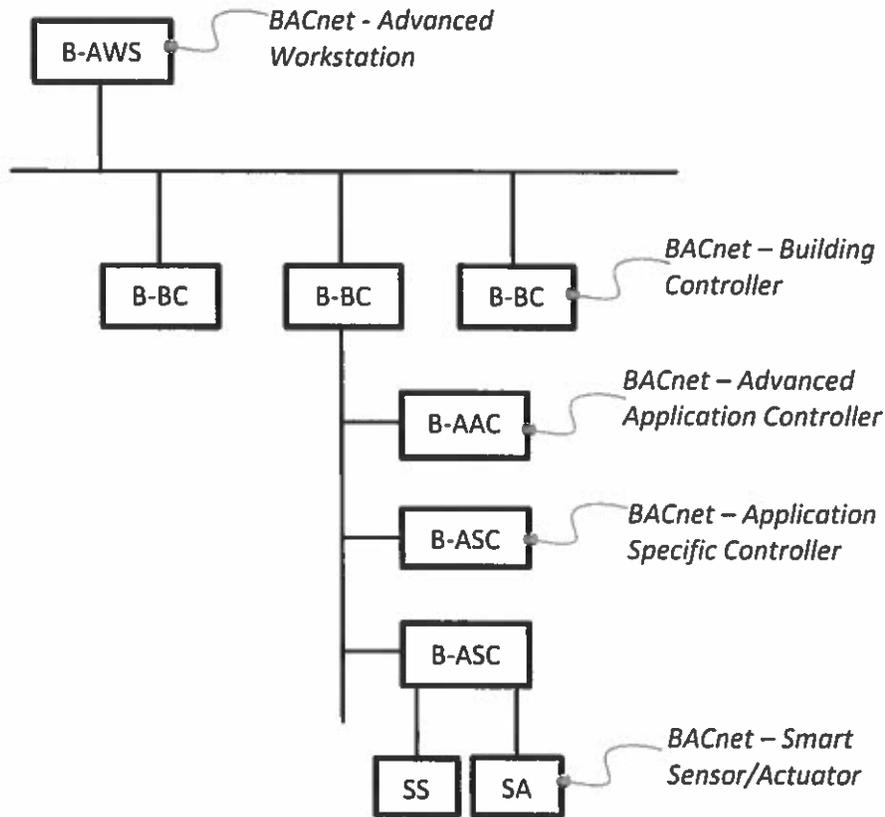
- Unless otherwise specified by WSU FP&M all components and controllers will require integration via BACnet and will adhere to the ASHRAE 135-2016 BACnet Standard to ensure interoperability between all systems. BACnet devices shall be via Ethernet (BACnet IP) and or RS-485 (BACnet MSTP) as specified.
- Other acceptable industry-standard, open communication is currently limited to the following protocols:
 - MODBUS IP - MODBUS IP communication
 - OPC DA - OLE for Process Control, OPC DA 2.05, 3.0
 - SNMP - SNMP Agents monitoring (V1 and V2)
 - IEC 61850 - protocol for electrical substations and devices
- 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.
- 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.

Building Automation Network

- Refer to Appendix _ For the Wayne State University Building Automation System Architecture diagram
- All building level controllers shall be integrated into the WSU Desigo CC BMS through the Wayne State University IT network. Qualified personnel shall be provided to work with the Wayne State IT and Systems Integration personnel as needed to deliver a fully functional system.
- All building level controllers integrating in to the WSU Desigo CC BMS shall be fully programmable to meet the unique requirements of the facility it will control. The WSU Desigo CC BMS shall be capable of peer-to-peer communications with building level controllers, BMS clients, and subordinate BMS servers.
- All networked controllers and software shall be BTL listed at the time of installation and shall communicate with one of the following industry standard open protocols:
 - BACnet /IP
 - MODBUS IP
 - OPC DA
 - SNMP
- Building Level Controllers shall support subnetwork protocols depending on the type of field level equipment or application. Subnetworks shall be limited to:
 - BACnet MS/TP
 - MODBUS RTU
- Communication involving BACnet control components (i.e. all types of controllers and operator interfaces) shall conform to ASHRAE 135-2016 BACnet standard. BACnet control components will communicate directly with the WSU IT network and shall not require an intermediary device such as a BACnet Router to facilitate communication with the WSU Desigo CC BMS. Additionally, networks and protocols proprietary to one company or distributed by one company are prohibited.



The following diagram is a representation of the functional relationship and hierarchy of BACnet device types on the WSU Desigo CC BMS network.



Functional relationship and hierarchy of BACnet

- 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 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.
- 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.



INSTALLER AND INTEGRATOR SCOPE

SUMMARY

The following defines the responsibilities of the installing contractors and the Master Integrator on all Projects of all sizes involving integrated systems. These are the minimum required responsibilities and projects will not be accepted until contractor meets the minimum portion of scope as listed.

Installing Contractor Scope:

1. Provide completed integration checklists and detailed project submittals to Facilities Operations Engineering Controls Team and Integration Contractor for review and approval.
 - a. Controls and related peripherals must not begin to be installed until integration Checklists and submittals are approved by Facilities Operations Engineering and Master Integrator.
2. Install systems and control panels as designed, specified and approved by project manager and Facilities Operations Engineering.
3. Provide cable/wiring to add devices into existing network, and/or home run devices to identified controller location
4. Provide BACnet/IP level integration (Device and point discovery, naming, etc.)
5. Structure Architecture to match Wayne State University Standard (Reference Appendix A).
6. Confirm proper communication and operation of all devices and points.
7. Tag all points per WSU point tagging convention
8. Provide complete and accurate as-built and close-out documentation.

**** Note: If installer does not have qualified/certified personnel on staff to perform any items 3-7, they must have Master Integrator or Temperature Control Contractor complete. If Temperature Control Contractor is installing the designated controller panel as part of their scope of work, they shall be the responsible party for joint commissioning with Master Integrator. ****

Master Integrator Scope:

1. Review Integration Checklist's as provided by installing contractor. Master Integrator to verify device addresses and instance ID's. WSU to provide IP addresses for network integration.
2. Where controller is contractor-provided third party device, confirm proper driver set and I/O communication card and licensing has been ordered and available on Desigo Platform. Confirm controller is licensed Open NICS and not restricted to a specific brand ID.
3. Configure Server connections to directly integrated devices.
4. Verify proper network and location information following standards and utilizing proper protocols.
5. Verify each piece of integrated equipment has been integrated and communicating on the network
6. Verify all points have been integrated with all required points and tagged properly.
7. Verify connected structure matches WSU Standard.
8. Test all equipment and points for read/write capability.
9. Eliminate any standalone schedules.
10. Provide Graphical Interface.
11. Provide Alarm logic, graphics, and communication following "Alarming Standards" as listed in Section 1.7 of this document.
12. Provide Trending and Historical Records as per Section 1.4 in this document.
13. Configure required system scheduling, including standard WSU campus-wide schedules and local schedules.
14. Provide user access as required by WSU.
15. Verify close-out documentation and provide as linked, accessible files via Desigo Integration platform server.

Note: Any deficiencies identified must be documented via RFI or the GC/Constructor's or Project Manager's requested method of communication and provided to Facilities Operations Engineering Controls Team.

Note: Minimum monthly meeting between Facilities Operations Engineering Controls Team, Installing Contractor, and Master Integrator is required on all projects.



QUALITY ASSURANCE

1. The Control System Contractor shall have a full service DDC office within 50 miles of the job site. The office shall be staffed with applications engineers, software engineers, and field technicians. This office shall maintain a parts inventory and shall have all the testing and diagnostic equipment necessary to support this work, as well as trained staff in the use of this equipment.
2. The Control System Contractor shall be responsible for the complete installation and proper operation of the system. The Control System Contractor shall exclusively be in the regular and customary business of design, installation and service of computerized building management systems similar in size and complexity to the specified system. Subcontracting or using a 3rd party for installing, programming/commissioning of devices (with the exception of the Master Systems Integrator) is not acceptable.
3. Control/TC Shop drawings shall contain all items and processes as specified by MEP drawings. Any additions or exclusions from the stamped MEP set of record shall be approved by the engineer of record AND Wayne State University.
4. Shop drawing of the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturer's catalog data sheets and installation instructions. Submit in printed and electronic format. Samples of written controller checkout Sheets and Performance Verification procedures for applications similar in scope shall be included for approval.
5. Shop drawings shall also contain complete wiring schematic diagrams, site specific sequences of operations, controls system bus layout, and any other details required to demonstrate that the system has been coordinated and will function as a system. Terminal identification and schedules shall be show on the shop drawings.
6. Upon completion of the work, As-Built shop drawings shall be provided to the Master Systems Integrator and Facilities Operations Engineering Controls Team.
7. Any deviations from these standards or the work indicated on the drawings shall be clearly identified in the submittals and approved by the engineer of record AND the Facilities Operations Engineering Controls Team.

Pre-Installation Meetings

1. The Temperature Controls System Contractor, WSU Controls Team, and the Master System Integrator shall convene a minimum of one month prior to starting work. Regular meetings shall be held until owner training has been provided, project is complete, turned over and accepted.

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.
 - 6. Service meters.
 - 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, 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. 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.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 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:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - 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.
 3. Transition Service-Line Risers: Factory fabricated and leak tested.
 - 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:
 - 1) Lyall, R. W. & Company, Incorporated (www.rwlyall.com)
 - 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:
 - 1) Lyall, R. W. & Company, Incorporated (www.rwlyall.com)
 - 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:
 - 1. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 - 2. Corrugated stainless-steel tubing with polymer coating.
 - 3. Operating-Pressure Rating: 0.5 psig.
 - 4. End Fittings: Zinc-coated steel.
 - 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.
 - 4. CWP Rating: 125 psig.
- 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.
- B. 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.
- 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.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.

4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 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.
 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 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)
 - c. Lyall, R. W. & Company, Incorporated (www.rwlyall.com)
 - d. McDonald, A. Y. Mfg. Co. (www.aymcdonald.com)
 2. Body: Bronze, complying with ASTM B 584.
 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.
 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 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)
 - b. McDonald, A. Y. Mfg. Co. (www.aymcdonald.com)
 2. Body: Bronze, complying with ASTM B 584.
 3. Plug: Bronze.
 4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 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:
 - a. McDonald, A. Y. Mfg. Co. (www.aymcdonald.com)
 - 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.

6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 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)
 - c. McDonald, A. Y. Mfg. Co. (www.aymcdonald.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.
 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 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)
 - b. Lyall, R. W. & Company, Incorporated (www.rwlyall.com)
 2. Body: PE.
 3. Ball: PE.
 4. Stem: Acetal.
 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

- A. Automatic Gas Valves: Comply with ANSI Z21.21.
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.
 3. Seats and Disc: Nitrile rubber.
 4. Springs and Valve Trim: Stainless steel.
 5. Normally closed.
 6. Visual position indicator.
 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.
 4. Seats and Disc: Nitrile rubber.
 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.
 8. Normally closed.
 9. Visual position indicator.

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.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 6. Orifice: Aluminum; interchangeable.
 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 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.
 10. Overpressure Protection Device: Factory mounted on pressure regulator.

11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
 12. Maximum Inlet Pressure: 100 psig.
- C. Line Pressure Regulators: Comply with ANSI Z21.80.
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.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 6. Orifice: Aluminum; interchangeable.
 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 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.
 10. Overpressure Protection Device: Factory mounted on pressure regulator.
 11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
 12. Maximum Inlet Pressure: 5 psig.
- D. Appliance Pressure Regulators: Comply with ANSI Z21.18.
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
 2. Body and Diaphragm Case: Die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber.
 6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
 8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
 9. Maximum Inlet Pressure: 5 psig.

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:
 - a. Standard: ASSE 1079.
 - 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:
 - a. Advance Products & Systems, Incorporated (www.apsonline.com)
 - b. Calpico, Incorporated (www.calpicoinc.com)
 - c. Central Plastics Company. (www.centralplastics.com)
 - d. Pipeline Seal and Insulator, Incorporated (www.pipeline-seal.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.
- B. Comply with NFPA 54 and the Michigan Fuel Gas Code requirements for prevention of accidental ignition.

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:
 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 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.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - 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

SECTION 232113 HYDRONIC 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 pipe and fitting materials and joining methods for the following:
 1. Hot-water heating piping.
 2. Chilled-water piping.
 3. Dual-temperature piping.
 4. Makeup-water piping.
 5. Condensate-drain piping.
 6. Air-vent piping.
 7. Safety-valve-inlet and -outlet 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.
 1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 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. Dual-Temperature-Water Piping: 125 psig at 200 degrees F.
 - 4. Makeup-Water Piping: 80 psig at 150 degrees F.
 - 5. Condensate-Drain Piping: 150 degrees F.
 - 6. Air-Vent Piping: 200 degrees F.
 - 7. 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:
 - a. Cambridge-Lee Industries Incorporated.
 - b. Cerro Flow Products Incorporated.
 - c. Mueller Industries Incorporated.
 - d. 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:
 - a. NIBCO INC.
 - b. 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.
- E. Wrought-Copper Unions: ASME B16.22.

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.
- E. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 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:
1. Material Group: 1.1.
 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..

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 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. Dual-temperature-water piping, aboveground, NPS 3 and smaller shall be the following:
 - 1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- F. Dual-temperature-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.
- G. Makeup-water piping installed aboveground shall be the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- H. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- I. 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.
- J. 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. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
 - 1. pH: 7.0 to 9.
 - 2. "P" Alkalinity: 100 to 500 ppm.
 - 3. Boron: 100 to 200 ppm.
 - 4. Chemical Oxygen Demand: Maximum 100 ppm. Modify this value if closed system contains glycol.
 - 5. Corrosion Inhibitor:
 - a. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
 - 6. Soluble Copper: Maximum 0.20 ppm.
 - 7. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.
 - 8. Total Suspended Solids: Maximum 10 ppm.
 - 9. Ammonia: Maximum 20 ppm.
 - 10. Free Caustic Alkalinity: Maximum 20 ppm.
 - 11. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maximum 1000 organisms/ml.
 - b. Total Anaerobic Plate Count: Maximum 100 organisms/ml.
 - c. Nitrate Reducers: 100 organisms/ml.
 - d. Sulfate Reducers: Maximum zero organisms/ml.
 - e. Iron Bacteria: Maximum zero organisms/ml.
- B. Install bypass chemical feeders (in the form of a cartridge water filter assembly with removable head plate) in each hydronic system.
 - 1. Install in upright position with top of funnel not more than 48 inches above the floor.
 - 2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
 - 3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.
- C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

- E. Fill systems indicated to have glycol solutions with deionized water and the following concentrations:
 - 1. Hot-Water Heating Loop Piping with Glycol: Minimum 50 percent ethylene glycol.
 - 2. Dual-Temperature Heating and Cooling Water Piping: Minimum 50 percent ethylene glycol.

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.
 - 9. Verify lubrication of motors and bearings.

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.
 - 6. Safety-valve-inlet and -outlet 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:
 - a. Armstrong Pumps, Incorporated..
 - 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.
 - 8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 9. Handle Style: Lever, with memory stop to retain set position.
 - 10. CWP Rating: Minimum 125 psig.
 - 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:
 - a. Armstrong Pumps, Incorporated..
 - 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. Stem Seals: EPDM O-rings.
 - 6. Disc: Glass and carbon-filled PTFE.
 - 7. Seat: PTFE.
 - 8. End Connections: Flanged or grooved.
 - 9. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 10. Handle Style: Lever, with memory stop to retain set position.
 - 11. CWP Rating: Minimum 125 psig.
 - 12. Maximum Operating Temperature: 250 degree F.
- E. Diaphragm-Operated Safety Valves: ASME labeled.
 - 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..
 - e. Spence Engineering Company, Incorporated..
 - f. Watts Regulator Co.
 - 2. Body: Bronze or brass.
 - 3. Disc: Glass and carbon-filled PTFE.
 - 4. Seat: Brass.
 - 5. Stem Seals: EPDM O-rings.
 - 6. Diaphragm: EPT.
 - 7. Wetted, Internal Work Parts: Brass and rubber.
 - 8. Inlet Strainer: stainless steel removable without system shutdown.
 - 9. Valve Seat and Stem: Noncorrosive.

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:
 - a. Flow Design Incorporated..
 - 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.
8. Minimum CWP Rating: 300 psig.
9. Maximum Operating Temperature: 250 degrees F.

2.3 FLOW MEASURING DEVICES

A. Manufacturers:

1. Calibrated Balancing Valves
 - a. Armstrong Pumps, Incorporated..
 - b. Bell & Gossett Domestic Pump.
 - c. Gerand 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.
5. Pressure Rating: 250 psig.
6. Temperature Rating: 250 degrees.
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.
6. Discharge Connection: NPS 1/8.
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.
 - 4. Operator: Noncorrosive metal float.
 - 5. Inlet Connection: NPS 1/2.
 - 6. Discharge Connection: NPS 1/4.
 - 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.
 - 4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
 - 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.
 - 6. Size: Match system flow capacity.
 - 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. Triple 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:
 - 1. Close-coupled, in-line centrifugal pumps.
 - 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.
 6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
- 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.
 - c. Motor Bearings: Grease-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.
- 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:
 1. Beckett Corporation. (www.beckett pumps.com)
 2. Hartell Pumps Div.; Milton Roy Co. (www.hartell.com)
 3. Little Giant Pump Co. (www.littlegiant.com)
 4. Mepco, LLC. (www.mepcolc.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.
 - 6. Start motor.
 - 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. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

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."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- 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:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250degreesF.

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.
- D. 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.
- 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.
6. Pressure Rating: Factory test at minimum 400 psig.
7. Maximum Operating Temperature: 330degreesF.

F. Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
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.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250degreesF.

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.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275degreesF.

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.
4. Seat: Non-rotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275degreesF.

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.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275degreesF.

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.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.

2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 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.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240degreesF.
 8. Manual operator.
- 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.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat Disc: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240degreesF.
- G. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 degrees F.
 6. Superheat: Adjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 450 psig.
- 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.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 5. Seat: Polytetrafluoroethylene.
 6. Equalizer: Internal.
 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.
 8. End Connections: Socket.
 9. Throttling Range: Maximum 5 psig.
 10. Working Pressure Rating: 500 psig.
 11. Maximum Operating Temperature: 240 degrees F.
- I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275degreesF.
- 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.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275degrees F.
- K. Moisture/Liquid Indicators:

1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in ppm.
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 240degrees 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.
 3. Desiccant Media: Activated charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Working Pressure Rating: 500 psig.
 9. Maximum Operating Temperature: 240degrees F).
- M. Permanent Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Working Pressure Rating: 500 psig.
 9. Maximum Operating Temperature: 240degrees 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.
 3. Body: Welded steel with corrosion-resistant coating.
 4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
 5. End Connections: Socket or threaded.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 275degrees F.
- O. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or threaded.
 3. Working Pressure Rating: 500 psig.
 4. Maximum Operating Temperature: 275 degrees.

2.4 REFRIGERANTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Atofina Chemicals, Inc.
 2. DuPont Company; Fluorochemicals Div.
 3. Honeywell, Inc.; Genetron Refrigerants.
 4. INEOS Fluor Americas LLC.
- B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

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 DEFINITIONS

- A. EEPROM: Electrically erasable, programmable read-only memory.
- 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. RO: Reverse osmosis.
- D. TDS: Total dissolved solids.
- E. UV: Ultraviolet.

1.4 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, dual-temperature water and glycol cooling, 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.
 - 7. Ammonia: Maintain a maximum value of 20 ppm.
 - 8. Free Caustic Alkalinity: Maintain a maximum value of 20 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.

1.5 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.
 - 1. Wiring Diagrams: Power and control wiring.
- 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.
 - 2. Water Analysis: Illustrate water quality available at Project site.

1.6 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.

1.7 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.
 - 4. Customer report charts and log sheets.
 - 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 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Owner approved equivalent

2.3 MANUAL CHEMICAL-FEED EQUIPMENT: CHILLED, HEATING WATER AND HYDRONIC LOOPS SYSTEMS

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
 - 1. Capacity: 2 gallon.
 - 2. Minimum Working Pressure: 175 psig.

2.4 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.

2.5 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.
 - c. Pressure Rating: Minimum 2000 psig.
 - d. Temperature Rating: Minimum 850 deg F.
 - 2. Shell: Cooling water.
 - a. Material: ASTM A 666, Type 304 stainless steel.
 - b. Pressure Rating: Minimum 250 psig.
 - c. Temperature Rating: Minimum 450 deg F.
 - 3. Capacities and Characteristics:
 - a. Tube: Sample.
 - 1) Flow Rate: 0.25 gpm.
 - 2) Entering Temperature: 400 deg F.
 - 3) Leaving Temperature: 88 deg F.
 - 4) Pressure Loss: 6.5 psig.
 - b. Shell: Cooling water.
 - 1) Flow Rate: 3 gpm.
 - 2) Entering Temperature: 70 deg F.
 - 3) Pressure Loss: 1.0 psig.
- 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.

2.6 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.

2.7 FILTRATION EQUIPMENT

- A. Bag or Cartridge-Type Filters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Haramsco – 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 WaterBettter
 - 1) Number Required: 4
 - 2) Nominal Diameter: 2-3/4 inches
 - 3) Nominal Length: 9-3/4 inches
 - 4) Media Material: Polyester.

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, chilled water, dual-temperature 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.
- E. Water Filters: Install in closed hydronic systems, including hot-water heating, chilled water, dual-temperature 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:
1. Silica: ASTM D 859.
 2. Steam System: ASTM D 1066.
 3. Acidity and Alkalinity: ASTM D 1067.
 4. Iron: ASTM D 1068.
 5. Water Hardness: ASTM D 1126.

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

SECTION 233113 METAL DUCTS

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.
 - 3. Single-wall, round and flat oval spiral-seam ducts and formed fittings.
 - 4. Duct liner.
- 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.
 9. Methods for duct and building attachment.
 10. Vibration isolation.
 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:
1. AWS D1.1, "Structural Welding Code-Steel," for hangers and supports.
 2. AWS D1.2, "Structural Welding Code-Aluminum," for aluminum supporting members.
 3. AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. NFPA Compliance:
1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 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 1-12s.

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:
 - a. McGill AirFlow Corporation.
 - 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. Elgen Manufacturing
 - c. McGill AirFlow Corporation.
 - 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

- A. Fiber Glass Duct Liner: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1071. Maximum temperature 250°F (ASTM C 411); air velocity 6000 fpm (ASTM C 1071). Maximum Flame Spread Index: 25; Maximum Smoke Developed Index 50; (NFPA 255, UL 723, ASTM E 1104). Fungi and Bacteria resistant (ASTM C 665, ASTM C 1138, ASTM G 21)
1. Manufacturers:
 - a. CertainTeed Corp.; Insulation Group.
 - b. Johns Manville International, Inc.
 - 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 12 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 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: Downstream from variable air volume air terminals (both round and rectangular trunk ducts. Individual runouts to diffusers are not lined, unless specifically indicated on the Drawings). 1 inch thick, unless noted differently on the Drawings.
 - 2. Return air ductwork: Ducts within 50 feet of a return air fan. 1 inch thick, unless noted differently on the Drawings.
 - 3. Exhaust air ductwork: None, except as indicated on the Drawings.
 - 4. Transfer air ducts: 1-inch thick
 - 5. Provide 1-inch thick 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.
 - 4. Seismic-restraint devices.
- 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

- 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
- 2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for casing joint and seam welding.
- 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.
 5. Applied Coating Color: Standard..
- 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..
 2. Vision Panel: Double-glazed, wire-reinforced safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
 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
b.	TL	26	23	30	42	51	59	58	58
 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	NRC
b.	Absorption	0.89	1.2	1.16	1.09	1.01	1.03	0.93	0.95

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:

a.	Frequency	63	125	250	500	1000	2000	4000	8000
b.	TL	26	23	30	42	51	59	58	58
 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	NRC
b.	Absorption	0.89	1.2	1.16	1.09	1.01	1.03	0.93	0.95

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)
 2. McGill AirSilence LLC. (www.mcgillairsilence.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..
 6. Double-Wall Casing Inner Panel: Perforated, galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent.

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	58
 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	NRC
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.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 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.
 1. General: Single component, acid curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 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:
 - 1. Manual volume dampers.
 - 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

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- 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.
 - 1. Galvanized Coating Designation: G90.
 - 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
 - 10. Vent Products Company, Incorporated.
- 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
 - 4. McGill AirFlow Corporation.

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
 12. Greenheck.
- 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.
 6. Blade Axles: Galvanized steel, Stainless steel, or Nonferrous.
 7. Bearings: Oil-impregnated bronze, molded synthetic or Stainless steel sleeve thrust or ball.
 8. Blade Seals: Felt, Vinyl, or Neoprene.
 9. Jamb Seals: Cambered stainless steel or aluminum.
 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.
 12. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon-locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.
- 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.
 2. Actuator: Hand quadrant for 3/8 inch square extended shaft.
 - a. Finish: Mill galvanized.
 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.
 - 3. Nailor Industries 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.
- D. Fire Rating: 1-1/2.
- 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.
 - 3. Nailor Industries 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.
 - 6. Damper Motors: two-position action.

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.
 3. Nailor Industries 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.
 4. Heat-Responsive Device: Resettable, 165 deg F rated fusible links.
 5. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.
 6. Blades: Roll-formed, horizontal, overlapping, 0.063-inch-thick, galvanized sheet steel.
 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.
 10. Damper Motors: Two-position action.
 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.
 - 7. Vibro-Acoustics.
- 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.
 - 6. Sheetmetal Connectors 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.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- 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.
 - f. McGill AirFlow Corporation.
 - 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.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
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.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
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
4. McGill AirFlow Corporation.
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.
2. Maximum Air Velocity: 5000 fpm.
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:

	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
1) 8 inch dia.	11	20	27	31	26	12
2) 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.
 3. Head and Hand Access: 18 by 10 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 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:
 - 1. E90-97 – Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss through Building Partitions.
 - 2. E336-97 – Standard Test Method for Measurement of Airborne Sound Insulation in Buildings
 - 3. E413-87 – Classification for Rating Sound Insulation
 - 4. E477-13e1 - Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers

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:

125 Hz	250 Hz	500 Hz	1kHz	2kHz	4kHz	8kHz
1.6	3.4	3.7	4.2	3.0	2.0	0.8

- 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):

125 Hz	250 Hz	500 Hz	1kHz	2kHz	4kHz	STC
15	19	21	28	33	37	26

- 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:
 - 1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange.

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.
 8. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 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.
 6. Spark-Resistant Construction: AMCA 99.
 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.
 8. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 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.
 6. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
 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.
 - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 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 per cent.
 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

SECTION 233600 AIR TERMINAL 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. 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)
 2. Price Industries. (www.price-hvac.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.
 2. Damper Position: Normally open.
- 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)
 - 2. Price Industries. (www.price-hvac.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.
 - 2. Damper Position: Normally closed.
- 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 arresstance 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 arresstance 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

SECTION 233713 DIFFUSERS, REGISTERS, AND GRILLES

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 following:
 - a. Price Industries.
 - b. Titus.
 2. Face Style: four cones.
 3. Mounting: Duct connection.
 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 following:
 - 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 following:
 - 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 following:
 - a. Price Industries.
 - b. Titus..
- B. Linear Slot Diffuser:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Price Industries.
 - b. Titus.
- C. Ceiling-Integral Continuous Diffuser:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 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.

3. Mounting: Concealed.
 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.
 3. Mounting: Concealed.
- C. Fixed Face Register:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Price Industries.
 - b. Titus.
 2. Material: Aluminum.
 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.
 8. Mounting: Concealed.
 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.
 2. Material: Aluminum.
 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.
 2. Material: Aluminum.
 3. Finish: Anodized, color selected by architect.
 4. Face Arrangement: Refer to Grille schedule.
 5. Frame: Refer to Grille schedule.
 6. Mounting: Concealed.
 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
 - 4. Laars Heating Systems Company.
- 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.
- F. Gas Train: Manual ball type gas valves, main gas valve, manual leak test valve, pilot gas pressure regulator, and automatic pilot gas valve.
- 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.
5. Combustion-Air Connections: Inlet and vent duct collars.
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.
 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.

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. Control interface shall include, but not be limited to Auxiliary Relay, Auxiliary Proving Switch, Alarm Contacts, Runtime Contacts, Manual Reset Low Water Cutoff, Flow Switch, High and Low Gas Pressure Switches, Tank Thermostat, Three Wall Thermostat/Zone Controls, System Supply Sensor, Outdoor Sensor, Building Management System Signal, Modbus Control Contacts and Cascade Control Circuit.

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 AI 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 SCREW 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, screw water chillers.

1.3 DEFINITIONS

- A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- B. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
- C. IPLV: Integrated part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 506/110 and referenced to ARI standard rating conditions.
- D. KW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
- E. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 506/110 and intended for operating conditions other than the ARI standard rating conditions.

1.4 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.

1.5 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.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.

1.7 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.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

1.9 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.

1.10 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 PACKAGED AIR-COOLED WATER CHILLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. McQuay International.
 2. Trane.
 3. York International Corporation.
- B. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.

C. Cabinet:

1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
2. 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.
3. Casing: Galvanized steel.
4. Full Unit Louvered Panels.
5. 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.
6. Sound-reduction package consisting of the following:
 - a. Acoustic enclosure around compressors.
 - b. Reduced-speed fans with acoustic treatment.
 - c. High-performance fan design to reduce sound.
 - d. Designed to reduce sound level without affecting performance.

D. Compressors:

1. Description: Shall be direct drive, semi hermetic, rotary twin-screw type, including: muffler, temperature actuated 'off-cycle' heater, rain-tight terminal box, discharge shutoff service valve, and precision machined cast iron housing. Design working pressure of entire compressor, suction to discharge, shall be 350 psig (24 barg) or higher. Compressor shall be U.L. Recognized.
2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
4. Capacity Control: Provide capacity control system capable of reducing unit capacity to 10% of full load for 2 compressor units. Compressor shall start in unloaded condition. Application of factory installed hot gas bypass shall be acceptable as required to meet specified minimum load.
5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.

E. 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.

F. Compressor Motor Controllers:

1. Across the Line: NEMA ICS 2, Class A, full voltage, non-reversing.

G. Refrigeration:

1. Refrigerant: R-410a. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit shall include 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.

H. Evaporator:

1. Brazed-plate or shell-and-tube design, as indicated.
2. Shell and Tube:
 - a. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
 - b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
 - c. Shell Material: Carbon steel.
 - d. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
 - e. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.

- f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
 - 3. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F.
 - 4. Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.
 - 5. Water boxes shall be removable to permit tube cleaning and replacement. Water boxes shall include liquid nozzle connections suitable for ANSI/AWWA C-606 couplings, welding, or flanges.
- I. Air-Cooled Condenser:
- 1. Plate-fin coil with integral sub-cooling on each circuit, rated at 450 psig.
 - a. Construct coils of copper tubes mechanically bonded to aluminum fins.
 - b. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
 - 2. Fans: Low sound fans and direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
 - 3. Fan Motors: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
 - 4. Fan Guards: Steel safety guards with corrosion-resistant coating.
- J. Electrical Power:
- 1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
 - 2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
 - 3. Wiring shall be numbered and color-coded to match wiring diagram.
 - 4. Install factory wiring outside of an enclosure in a raceway.
 - 5. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.
 - 6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
 - a. 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.
 - b. NEMA KS 1, heavy-duty, non-fusible switch.
 - c. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - 7. Provide each motor with overcurrent protection.
 - 8. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
 - 9. Phase-Failure and Under-voltage: Solid-state sensing with adjustable settings.
 - 10. Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
 - a. Power unit-mounted controls where indicated.
 - b. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.
 - 11. Control Relays: Auxiliary and adjustable time-delay relays.
 - 12. Indicate the following for water chiller electrical power supply:
 - a. Current, phase to phase, for all three phases.
 - b. Voltage, phase to phase and phase to neutral for all three phases.
 - c. Three-phase real power (kilowatts).
 - d. Three-phase reactive power (kilovolt amperes reactive).
 - e. Power factor.
 - f. Running log of total power versus time (kilowatt hours).
 - g. Fault log, with time and date of each.
- K. Controls:
- 1. Stand-alone, microprocessor based.
 - 2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.

3. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
 - a. Date and time.
 - b. Operating or alarm status.
 - c. Operating hours.
 - d. Outside-air temperature if required for chilled-water reset.
 - e. Temperature and pressure of operating set points.
 - f. Entering and leaving temperatures of chilled water.
 - g. Refrigerant pressures in evaporator and condenser.
 - h. Saturation temperature in evaporator and condenser.
 - i. No cooling load condition.
 - j. Elapsed time meter (compressor run status).
 - k. Pump status.
 - l. Anti-recycling timer status.
 - m. Percent of maximum motor amperage.
 - n. Current-limit set point.
 - o. Number of compressor starts.
4. Control Functions:
 - a. Manual or automatic startup and shutdown time schedule.
 - b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water temperature.
 - c. Current limit and demand limit.
 - d. External water chiller emergency stop.
 - e. Anti-recycling timer.
 - f. Automatic lead-lag switching.
5. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
 - a. Low evaporator pressure or high condenser pressure.
 - b. Low chilled-water temperature.
 - c. Refrigerant high pressure.
 - d. High or low oil pressure.
 - e. High oil temperature.
 - f. Loss of chilled-water flow.
 - g. Control device failure.
6. Building Automation System Interface: Factory-installed hardware and software to enable building automation system to monitor, control, and display water chiller status and alarms.
 - a. ASHRAE 135 (BACnet) communication interface with building automation system shall enable building automation 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 building automation system.

L. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
2. Thickness: 3/4 inch.
3. Factory-applied insulation over cold surfaces of water chiller components.
 - a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
4. Apply protective coating to exposed surfaces of insulation.

M. Accessories:

1. Factory-furnished, chilled- water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.
3. Factory-furnished spring isolators for field installation.

N. Capacities and Characteristics:

1. Low Ambient Operation: Chiller designed for operation to 0 deg F.

2.2 SOURCE QUALITY CONTROL

- A. Perform functional test of water chillers before shipping.
- B. Factory performance test water chillers, before shipping, according to ARI 506/110, "Water Chilling Packages Using the Vapor Compression Cycle."
- C. For water chillers located outdoors, rate sound power level according to ARI 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, 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 and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WATER CHILLER INSTALLATION

- A. Install water chillers on support structure indicated.
- B. Equipment Mounting:
 - 1. Install water chillers on cast-in-place concrete equipment bases.
 - 2. Comply with requirements for vibration isolation devices.
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
- E. Install separate devices furnished by manufacturer and not factory installed.

3.3 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. Install piping adjacent to chiller to allow service and maintenance.
- C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve. Make connections to water chiller with a union.
- D. Connect each drain connection with a union and drain pipe and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection if required.

3.4 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.
 9. Verify and record performance of chilled water flow and low-temperature interlocks.
 10. Verify and record performance of water chiller protection devices.
 11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Prepare a written startup report that records results of tests and inspections.

3.5 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.

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 and Seismic 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:
 - 1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans will bear AMCA-certified sound ratings seal.
 - 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 AIR HANDLING UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Haakon Industries
 - 2. Ingenia Technologies Incorporated
 - 3. Racan Industries
 - 4. Ventrol, Incorporated
 - 5. York Custom Air Handling
- B. General Description: Factory fabricate and assemble air handling units including components. Units will consist of cabinet, internally isolated fans, motor and drive assembly, heating coils, cooling coils, drain pans, humidifier manifold, internal dampers, filter sections, access sections, mixing section, plenums, silencers, and accessories, as indicated.
 - 1. Units will be of the sizes, types, arrangements and capacities as indicated on the Drawings and Schedules.
 - 2. Unit dimensions will be as indicated on the Drawings, with allowances made for minor variations in manufacturing methods.
 - 3. Fan sound ratings equivalent to the scheduled fan at scheduled operating conditions according to the manufacturer's published catalog data; unless indicated on the drawings.
- C. Sound Attenuators: Provide sound attenuators and mounting frames as indicated. Refer to drawings and Division 23 Section "Duct Accessories" for performance requirements.

2.2 4-INCH THICK DOUBLE WALL CABINET

- A. Base Frame: Structural steel "C" channel base frame with intermediate cross structural supports located on 12" centers. Base frame shall be joined continuously with welded connections.
 - 1. Minimum Height: Allow for drain connection trap.
 - 2. Lifting Lugs: Removable
- B. Floors: Floor surface shall be 12-gauge diamond checkered plate steel, all welded construction. Floor will be formed and sealed to form an integral water-tight drain pan 2-inches deep throughout the unit.
 - 1. Insulation: 4-inch thick fiberglass insulation within the structural floor cavity and protected from underneath by a galvanized steel liner.
 - 2. Drain Connections: Extended through the unit base frame, for floor drains in sections downstream of cooling coils, and as indicated on the Drawings.
- C. Walls and Ceilings Panels: 4-inch thick insulated double-wall acoustic panels. Panels will be internally fastened together with intermediate adjoining T- or Z- elements and will be externally sealed with a bead of polyurethane caulking compound to form a continuous, positive seal.
 - 1. Exterior Panel Materials: Minimum 16-gauge, G90 galvanized steel.
 - 2. Internal Panel Materials:
 - a. 20-gauge, minimum, Type 304 stainless steel solid panels upstream of cooling coil, 3 feet downstream of cooling coils, at humidifiers, and downstream of final filters.
 - b. 22-gauge, minimum, G90 galvanized steel perforated panels in supply fan section, and downstream plenum sections (except not downstream of final filters, where applicable).
 - 3. Unit cabinets will be designed to withstand air pressure differentials up to 10 inches w.g. positive static pressure, and up to 4 inches w.g. negative static pressure. Unit roof/ceiling assembly will be designed to support a 30-pound per square foot live load. Maximum deflection with the specified loads will not exceed 1/240 of the free span.
 - 4. Structural supports for the roof/ceiling shall be within the roof/ceiling panel thickness. Roof/ceiling shall be free span between the walls of the unit with no horizontal structural members below the roof/ceiling surface, and with no post or pipe supports unless contained with the unit wall panels.
 - 5. Unit construction shall provide a maximum leakage rate of not more than 1.0 percent at 10 inches w.g. positive and negative pressure.
 - 6. Provide framed and gasketed openings for ductwork, piping, and electrical conduit penetrations of cabinet walls. Closures around piping and conduit shall be completed according to details provided by the unit manufacturer.
- D. Insulation: Long resilient inorganic unfaced glass-fiber insulation, bonded with a thermosetting resin.
 - 1. Type: 4-inch thickness, 4 pounds per cubic foot density, compressed a minimum of 10 percent.
 - 2. Location and Application: Factory-applied with adhesive and mechanical fasteners, full thickness between the double walls of all section panels. All structural members shall be insulated to prevent condensation.
 - 3. Tedlar Film: Insulation within perforated wall panels shall be completely wrapped with Tedlar film (minimum of 4-mil thickness) to provide moisture protection and to isolate the insulation from the airstream.
- E. Thermal and Acoustical Performance: Tested by an independent laboratory to provide the following minimum performance.
 - 1. Minimum acoustic performance for panels and doors:

a. Octave Band:	125	250	500	1000	2000	4000
Absorption Coefficient:	.92	.92	1.04	1.07	1.06	1.00
Transmission Loss (STC-39):	22	30	44	53	57	63
 - 2. The thermal conductance of the panels shall not exceed 0.06 BTU /hr /sq. ft. /°F.

- F. Access Doors: Double-wall, solid insulated flush-mounted access doors with hinges, latches, handles, gaskets, and with same thickness as unit housing. Solid 16-gauge G90 galvanized steel, interior and exterior
 - 1. Provide full-sized access doors on fan sections, coil access sections, filter sections, and as indicated on the Drawings. Access doors shall be a minimum 18" wide.
 - 2. Fan section doors will have inspection windows, 8-inch x 8-inch minimum. Thermal conductance of the windows will not exceed 0.65 BTU /hr /sq. ft. /°F.
 - 3. Access door latches shall be operable from either side of door and shall be Ventlok 310 compression latches or equivalent with 304 stainless steel piano hinge.
 - 4. Access doors shall be fully gasketed with continuous ½" closed cell hollow round black neoprene gasket mechanically fastened to door frame.
 - 5. All access doors shall swing against unit air pressure.
- G. Fan Section Construction: Fan section will be equipped with a formed steel channel base for integral mounting of fan, motor, and casing panels. The fan scroll, wheel, shaft, bearings, and motor will be mounted on a structural steel frame with frame mounted on base with vibration isolators. Provide overhead motor removal system with rail and/or hoist beam with hoist assembly to facilitate motor removal.
- H. Condensate Drain Pans. Formed sections of Type 304 stainless steel. Fabricate condensate drain pans in sizes and shapes to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at maximum cataloged face velocity across the cooling coil.
 - 1. Condensate drain pans shall extend a minimum of 18" from leaving side of cooling coil and any humidifier dispersion tubes.
 - 2. Condensate drain pans shall be provided for condensate removal downstream of cooling coils. Where stacked coils are used, provide intermediate stainless steel drain pans and stainless steel condensate drain piping to lower pan.
 - 3. Drain pans shall be sloped (at not less than 1/4-inch per foot at any location) to provide positive drainage of condensate. Drainage shall be toward the "accessible" side of the units.
 - 4. Drain pans shall be double-wall construction with space between walls filled with foam insulation and sealed moisture tight.
 - 5. Drain pans shall be supplied with a 1-1/2-inch minimum drain connection, extended to the outside of the "accessible" side of the units.
 - 6. Drain pans shall be installed such that there is sufficient height to install a P-trap per the Details in the Drawings at the outlet of the drain.
- I. Marine Lights: Provide factory-mounted weather-resistant (enclosed and gasketed), vapor-tight, LED light in each fan section, and in each section with an access door. Fixture shall be complete with junction box, globe, aluminum globe guard, receptacle and bulb. Extend electrical wiring to a switch with pilot light located at an access door, and to a single point electrical power connection. Provide GFCI receptacle separate from the load side of the equipment.

2.3 FANS

- A. General: Fans and motors factory-installed inside unit cabinets on vibration isolation springs and structural steel bases.
 - 1. Flexible duct connection on discharge of each housed fan, and on the inlet of each plenum fan.
 - 2. Spring thrust restraints.
 - 3. OSHA Approved Fan Cages: Easily Removable
 - 4. Provide a factory dynamic balance of fans after installation. An IRD or PMC analyzer will be used to measure velocity, with final reading not exceeding 0.1-inch per second.
 - 5. Belt drives: Factory installed belt drives shall provide the design air flow at the design pressure.
- B. Shaft Bearings: Grease-lubricated ball bearings selected for L10 200,000 hours, with grease fittings extended to an accessible location outside the fan section.
- C. Vibration Isolation: Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation springs and structural steel fan bases.

- D. 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.
- E. Each fan shall be provided with an acoustic baffle assembly for added sound attenuation. Sound attenuation values shall be as indicated on the schedule.
- F. Each fan motor shall be provided vibration sensor to identify when a fan or motor bearing failure occurs. Sensor shall provide a warning to building automation sensor upon detection of vibration outside of normal operating conditions.
- G. Fan-Section Source Quality Control:
 - 1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans will bear AMCA-certified sound ratings seal.
 - 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.
 - 4. Fans shall bear AMCA certified performance ratings seal.
 - 5. All fan and motor assemblies shall be dynamically balanced by the manufacturer to a maximum allowable vibration of 0.040 inches per second at design RPM and a maximum 0.080 inches per second overall vibration limit. In addition, the manufacturer shall insure that no critical frequencies exist in the fan operating range by varying motor speed in 1Hz increments from design RPM to 50% of design RPM. The maximum allowable recorded vibration within this range shall be 0.080 inches per second.
- H. Plenum Fans
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Barry Blower, a division of Penn Fans
 - b. Twin City Fan Company
 - c. Greenheck
 - d. New York Blower
 - e. Loren Cook Company
 - 2. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
 - 3. Airfoil Wheels: Single-width-single-inlet construction with smooth-curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
 - 4. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - a. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 - b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
 - 5. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - a. Ball-Bearing Rating Life: ABMA 9, L10 at 200,000 hours.
 - b. Roller-Bearing Rating Life: ABMA 11, L10 at 200,000 hours.
 - 6. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - a. Service Factor Based on Fan Motor Size: 1.4.
 - b. Fan Pulleys: Cast iron or cast steel with split tapered bushing; dynamically balanced at factory.
 - c. Motor Pulleys:

- 1) Fixed pitch for use on fans with variable speed motor drives.
- 2) Fixed pitch for use with motors larger than 5 horsepower.
- d. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
 - 1) No fan may have less than two belts driving the wheel.
- e. 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.
- f. Motor Mount: Adjustable for belt tensioning.
- 7. Accessories:
 - a. Grounding Ring: Provide circumferential conductive micro fiber shaft grounding ring.
 - b. Each fan shall be provided with an isolation back draft damper to prevent bypass in the event of a failure.
- 8. Capacities and Characteristics:
 - a. Refer to the drawings for capacities and additional characteristics.
 - b. Wheel Material: Steel.
- I. Low Noise Plenum Fans (Alternate)
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AcoustiFLO
 - b. Or Approved Equal
 - 2. Description: Factory-fabricated, -assembled, -tested, and -finished, direct-drive plenum fans consisting of wheel, fan shaft, bearings, motor, fan shroud and support structure.
 - 3. Airfoil Wheels: Single-width-single-inlet construction with smooth-curved inlet cone; hollow die-formed, airfoil-shaped steel blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
 - 4. Fan Shroud: 16-gauge steel shroud lined with sound absorbing media; media shall be encapsulated with a UL approved membrane.
 - 5. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower.
 - a. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 - b. Grounded shaft required.
 - 6. Grease-lubricated motor bearings:
 - a. Bearing Rating Life: ABMA 9, L10 at 200,000 hours.
 - 7. Accessories:
 - a. Shaft grounding ring: AEGIS SGR.
 - b. Each fan shall be provided with an isolation back draft damper to prevent bypass in the event of a failure.
 - c. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
 - d. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 - 8. Capacities and Characteristics:
 - a. Refer to the equipment schedule for capacities and characteristics.

2.4 MOTORS

- 1. Refer to Division-23 Section "Division 23 Section "Common Motor Requirements for HVAC Equipment"
- 2. Motors shall be Premium Efficiency per NEMA MG1 type, shall have NEMA Class F insulation, shall meet NEMA Standard MD-1 Inverter Duty rating and shall be designed to withstand 1600V peak voltage spikes and rise times ≥ 0.1 microseconds. Motors shall have greasable ball bearings designed to deliver a minimum L10 life of 250,000 hours at full load and the maximum operating RPM of the associated fan. The opposite shaft end bearing shall be clamped to secure the bearing in the housing. Electrical characteristics and horsepower shall be as specified on the project schedule.

3. For efficient operation in a direct drive application, motors shall be capable of running continuously from 0 to 90 Hz and deliver full rated horsepower at 60 to 90 Hz operating frequencies. All motors shall maintain a minimum service factor of 1.15 throughout a 60 to 90 HZ operating range. Motors shall conform to a G2.0 balance per NEMA S2.19.
4. Motors shall be factory wired to a motor control center for connection to a disconnect switch or VSD. The motor control center shall include for each motor circuit a control device providing overload protection, short circuit protection and a manual disconnect means, and all circuits shall be wired to a common main panel terminal block and redundant VSD's. Each control device shall include an auxiliary output capable of providing remote notification of a motor failure.
5. Motors shall be warranted by the unit manufacturer for a full five (5) years from date of unit start-up.

2.5 VARIABLE SPEED DRIVES

- A. Refer to drawings for fan motors controlled by variable speed drives. Variable speed fan motor drives will be provided by the fan equipment manufacture. Provide one drive per fan.
- B. VSD Description: Variable-speed drive, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means 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.
- C. Variable speed drives including single point power non-fused disconnect switch shall be provided with the unit and installed in the field. Refer to Division-23 Section "Variable Speed Motor Controllers" for drive requirements and acceptable manufacturers.
- D. Belt drives shall be selected to provide design air flow at design pressure with the variable speed drive at 60Hz. Provide sheave changes as required to meet design requirements.

2.6 COILS

- A. General. Heating and cooling coils will be factory-mounted and factory-piped inside unit cabinets. Coils will be arranged for horizontal airflow. Headers and return bends will be completely enclosed within the casing. Piping connections will extend to the outside of casing through rubber grommeted penetrations.
- B. Coil Sections: Common or individual, insulated, stainless steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils.
- C. Water Coils: Self-draining coil fabricated according to ARI 410.
 1. Piping Connections: Threaded, on same end.
 2. Tubes: 5/8-diameter copper tube at 0.020-inch thick or 1/2-diameter copper tube at 0.016-inch thick.
 3. Fins: Aluminum 0.0075-inch thick; refer to equipment schedules for fin spacing. Fin and Tube Joint: Mechanical bond.
 5. Headers: Seamless copper tube with brazed joints; prime coated with drain and air vent tappings.
 6. Frames: Stainless-steel channel frame.
 7. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
 - a. Working-Pressure Ratings: 200 psig, 325 degrees F.

8. Source Quality Control: Test to 300 psig and to 200 psig underwater.
 9. Mounting: Provide coils with stainless steel racks, bulkheads, blockoffs and supports. For multiple and stacked coils, each coil shall be independently supported.
- D. Coil Removal: Coils and coil sections will be designed and constructed to facilitate removal of coils for maintenance and replacement.
1. Removable access panels will be bolted in place for coil removal. Coils will slide out of their respective sections without disrupting the continuity of the casing. Coils will be arranged for removal from the "accessible" side of the units.

2.7 FILTERS

- A. General: Filter holding frames will be factory-installed inside unit cabinets. Provide access sections with doors on both sides of unit for service access to air filters.
- B. Filters: Comply with NFPA 90A.
- C. Provide magnehelic filter gauge. Gauge shall have a 4" diameter face and die cast aluminum case and besel with acrylic cover. +/- 2% rated accuracy. Provide static pressure taps, tubing, connectors, and necessary accessories for filter pressure monitoring by building automation system. Refer to Division 23 specification "Sequence of Operation for HVAC Control."
- D. Refer to plans, schedules, and specification "Particulate Air Filtration" for filter requirements.

2.8 MIXING, FILTER, ACCESS AND PLENUM SECTIONS

- A. Dampers: Provide automatic control dampers as indicated. Refer to Division 23 Section "Building Automation Systems" for damper requirements.
- B. Damper Operators: Refer to Division 23 Section "Building Automation Systems" for damper operators.
- C. Sound Attenuators: Provide sound attenuators and mounting frames as indicated. Refer to Division 23 Section "Duct Accessories" for requirements.

2.9 ELECTRICAL CONNECTION

- A. Refer also to Mechanical Electrical Coordination schedule for electrical connection requirements.
- B. Unit shall be a single point power connection with 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 air handling units; verify that components are installed according to the component manufacturer's installation instructions.
- B. Examine areas and conditions for compliance with requirements for installation tolerances, concrete bases and curbs, and other conditions affecting performance of air-handling units.
- C. Examine rough-in for piping, power wiring, and control wiring; verify actual locations of connections prior to installation. Verify that piping and conduit will not obstruct air handling unit access doors.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install air-handling units level and plumb, in accordance with manufacturer's written instructions.
 1. Mount floor-mounted units on concrete equipment bases using neoprene pads to separate concrete and metal.
 - a. Secure units to anchor bolts installed in concrete equipment base.

- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:
 - 1. Arrange piping installations adjacent to units to allow unit service and maintenance. Piping shall not interfere with unit access doors.
 - 2. Arrange piping to facilitate removal and replacement of coils and equipment.
 - 3. Connect condensate drain pans using Type L copper tubing. Extend to the nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction. Provide adequate height on trap to assure water seal is maintained and condensate flows continuously during operation.
- B. Duct installations and connections are specified in other Division 23 sections. Make final duct connections with flexible connections.
- C. Electrical Connections: Coordinate the connection of fan motors and variable frequency drives, and connections to unit lights, to electrical systems and grounds as indicated and instructed by the manufacturer. Refer to Division 26 for electrical power wiring requirements.
- D. Automatic Controls: Coordinate the installation and connection of Automatic Control devices. Refer to Division 23 Section "Automatic Control Systems" for requirements.

3.4 AIR FILTER GAGES

- A. Install air filter pressure gages according to the manufacturer's installation instructions. Do not mount air filter gages on access doors or panels.
- B. Pressure tips shall be installed near the center of filter bank being measured.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Inspection: A factory-authorized service representative will perform the following:
 - 1. Inspect the field assembly of components and installation of air-handling units including piping, ductwork, and electrical connections.
 - 2. Prepare a written report on findings and recommended corrective actions.
 - 3. Provide a statement certifying the completed units have been installed in accordance with the manufacturer's engineered shop drawings and the manufacturer's installation instructions, and that unit installation is complete as intended.

3.6 ADJUSTING, CLEANING, AND PROTECTING

- A. Adjust water coil flow, with control valves to full coil flow, to indicated gpm.
- B. Adjust damper linkages for proper damper operation.
- C. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face.

3.7 STARTUP

- A. Final Checks before Start-Up: Perform the following operations and checks before start-up:
 - 1. Remove shipping, blocking, and bracing.
 - 2. Verify unit is secure on mountings and supporting devices and those connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
 - 3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 6. Set outside-air and return-air mixing dampers to minimum outside- air setting.
 7. Comb coil fins for parallel orientation. Repair any damaged fins or tubes.
 8. Install clean filters.
 9. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
 10. Disable automatic temperature control operators.
 11. Set face-and-bypass dampers to full face flow
 12. Verify fan alarms and control operation; both manual and automatic.
- B. Starting procedures for air-handling units:
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.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.
- D. Shut unit down and reconnect automatic temperature control operators.
- E. Startup report: The startup report shall indicate that the listed startup tasks have been performed and list the results.

3.8 DEMONSTRATION

- A. Demonstration Services: Provide a service representative to train Owner's maintenance personnel on the following:
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 7 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.
 - 1. Doors and Access Panels: Galvanized steel with polyurethane gaskets, hinges, and concealed fastening devices.
 - 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.
- F. Electric-Resistance Heating Coil: Enclosed finned-tube electric elements arranged for minimum of two stages, with thermal safety switches, manual-reset overload protection, and branch-circuit overcurrent protection.
- 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 SPLIT-SYSTEM 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Delegated design structural anchorage submission:
 - 1. Provide "Delegated Design Submittal" as defined in Division 23 section "Noise and Vibration Controls for HVAC Piping and Equipment"
- D. Samples for Initial Selection: For units with factory-applied color finishes.
- E. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
- F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- 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.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."
- ~~B.~~ Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

1.7 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. Filters: One set of filters for each unit.
 - 2. Fan Belts: One set of belts for each unit.
 - 3. Wireless remote controller: One additional remote controller for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mitsubishi Electronics America, Incorporated; HVAC Division.
 - 2. Carrier Air Conditioning; Division of Carrier Corporation.
 - 3. Lennox Industries Incorporated
 - 4. Sanyo Fisher (U.S.A.) Corporation
 - 5. Trane Company (The); Unitary Products Group.
 - 6. York International Corporation

2.2 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

- A. Cabinet: Enameled steel with removable panels on front and ends in black color or field paintable black, and discharge drain pans with drain connection.
- B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- C. Fan: Direct drive, centrifugal fan.
- D. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC."
 - 1. Special Motor Features: Multi-tapped, multispeed with internal thermal protection and permanent lubrication.
- E. Filters: Permanent, cleanable.
- F. Condensate Pump: Integral

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

- A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - 1. Compressor Type: Scroll.
 - 2. Minimum two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - 3. Variable-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
- D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.
- E. Fan: Aluminum-propeller type, directly connected to motor.
- F. Motor: Permanently lubricated, with integral thermal-overload protection.

- G. Low Ambient Kit: Permits operation down to 0 degrees F.
- H. Mounting Base: Polyethylene.

2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Controls for HVAC" and "Sequence of Operation."
- B. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor equipment status and alarms.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction and liquid lines with flared fittings at both ends. Piping thickness shall be appropriate for selected refrigerant pressures. Insulation shall be of sufficient thickness to meet minimum energy code requirements for indoor and outdoor installation AND for interior piping, to prevent condensation at indoor temperature and humidity conditions of 75 deg F and 55% RH.
- E. Wireless remote controller.
- F. Automatic fan speed control.
- G. Self check function with on-board diagnostics.
- H. Advanced microprocessor control.
- I. Auto changeover for cooling and heat.

2.5 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 units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 23 Section "Vibration Controls and Seismic Restraints for HVAC Piping and Equipment."
- D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- E. Refrigerant piping shall be run straight and in alignment/parallel to building lines with minimal kinks and bends in piping.
- F. Ensure continuous insulation on piping and at connections to equipment to prevent condensation at indoor temperature and humidity conditions of 75 deg F and 55% RH.
- G. Mount outdoor condensing units on manufactured support assemblies. Support assemblies shall include self-ballasting base that does not impact warranty of roofing system. Assembly shall include provisions for vibration dampening and secure attachments (bolts or steel channels) to condensing units.

3.2 CONNECTIONS

- A. Connect piping to condensing units and interior fan coil units per manufacturer's recommendations. Include ball valves, stop valves, service ports and strainers at equipment connections.
- B. Install piping adjacent to unit to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized 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. 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, 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. Remove and replace malfunctioning units and retest as specified above.

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. Perform functional performance test on all equipment.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

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:
 1. Heatcraft Refrigeration Products LLC; Heat Transfer Division.
 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.

END OF SECTION

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:
 - 1. Hydronic finned-tube radiation heaters.
 - 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. Indeco.
 - 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.
 - 6. Wiring Diagrams: Power, signal, and control wiring.
- 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.
 - 2. McQuay International.
 - 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.
 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 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. Indicate location and arrangement of piping valves and specialties.
 - 7. Wiring Diagrams: Power, signal, and control wiring.

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.
 - 2. McQuay International.
 - 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.

- 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 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

SECTION 239000 DUST COLLECTORS

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/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.
- F. Fan Section: Centrifugal fan, all-welded steel construction; flat, backwardly-inclined blades, non-overloading, direct-driven motor. Field mount fan to side of collector. Flanged fan inlet and outlet. Provide manual damper at fan outlet for adjustment of fan volume.
- 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.
- 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: Provide 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 receiver
- 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. Ground test documentation
 7. 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



WAYNE STATE UNIVERSITY

Gateway Theater Complex

WSU No. 189-178578 | HAA No. 2016034.00

Project Manual

Volume 3 of 4

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27 - Communications

28 - Electronic Safety & Security

100% Design Development

January 30, 2019

HGA

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END OF SECTION

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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.
6. Supports and anchorages.
7. Touchup painting.
8. Electric Service Outage and Energizations.

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:
 - a. Contract Price adjustment.
 - 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 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.

1.13 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;

SPACE	ROOM CRITERIA (NC)
Flex Theater	TBD
Proscenium Theater	TBD
Jazz Center	TBD

- 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 products 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. Kaf-Tech
 5. Service Wire Co.
 6. 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. 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:
1. Single circuit and multicircuit with color-coded conductors.
 2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- 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)
 - 6. Service Wire Co.
 - 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.
 - 3. Comply with UL 4.
 - 4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Circuits:
 - 1. Single circuit and multicircuit with color-coded conductors.
 - 2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- 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.
 - 3. Gardner Bender.
 - 4. Hubbell Power Systems, Inc.
 - 5. Ideal Industries, Inc.
 - 6. ILSCO
 - 7. NSi Industries LLC.
 - 8. O-Z/Gedney; a brand of the EGS Electrical Group.
 - 9. Service Wire Co.
 - 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.
- G. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

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: NFPA 262.

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.
 3. Southwire Company.
- 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:
 - 1. Comply with TIA-568-C Series of standards.
 - 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.
 - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
 - 9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
 - 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:
 - 1. Comply with TIA-568-C.2.
 - 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 TDMM 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
14. Southwire Incorporated.
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:
 1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
 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.
 - 4. Connections to Structural Steel: Welded 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.
 - 4. Single-phase motor and appliance branch 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.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 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).
 - 5. Substations and Pad-Mounted Equipment: 5 ohms.
 - 6. Manhole Grounds: 10 ohms.
- 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.
 - 8. Construction requirements for concrete bases.

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.
 - 1. Hangers. Include product data for components.
 - 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.
 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 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.
 3. Channel Material: 6063-T5 aluminum alloy.
 4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 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.
 7. Hanger Rods: Threaded steel.

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.
 - 4. Boxes, enclosures, and cabinets.
 - 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.
 - 2. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

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 C80.3 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 raceway 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.
 - 3. Mono-Systems, Inc.
 - 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.
 - 4. Erickson Electrical Equipment Company.
 - 5. FSR Inc.

6. Hoffman; a Pentair company.
 7. Hubbell Incorporated; Killark Division.
 8. Kraloy.
 9. Milbank Manufacturing Co.
 10. Mono-Systems, Inc.
 11. O-Z/Gedney; a brand of EGS Electrical Group.
 12. Plasti-Bond
 13. RACO; a Hubbell Company.
 14. Spring City Electrical Manufacturing Company.
 15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
 16. Thomas & Betts Corporation.
 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] [aluminum], 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 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 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.
 - 7. Cast-in-place manholes.
 - 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:
 - 1. 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 nonconcrete 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.
 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 3. Anamet Electrical, Inc.
 4. Bridgeport Fittings, Inc.
 5. Electri-Flex Company.
 6. O-Z/Gedney; a brand of EGS Electrical Group.
 7. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
 8. Republic Conduit.
 9. Robroy Industries.
 10. Southwire Company.
 11. Thomas & Betts Corporation.
 12. Western Tube and Conduit Corporation.

13. Wheatland Tube Company; a division of John Maneely Company.

- 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.
 - 6. Condux International, Inc.
 - 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.
 - d. Quazite: Hubbell Power System, 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.
 - 3. Bands and tubes.
 - 4. Tapes and stencils.
 - 5. Tags.
 - 6. Signs.
 - 7. Cable ties.
 - 8. Paint for identification.
 - 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.
- B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- 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[or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit].
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Color for Neutral: White.
 - 4. Color for Equipment Grounds: Green.
- 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. Grafoplast 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. Grafoplast Wire Markers
 - f. Ideal Industries, Inc.
 - g. LEM Products Inc.
 - h. Marking Services, Inc.
 - i. Panduit Corp.
 - j. Seton Identification Products
 - 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 [black and white] [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).
 - 4. Color: Black, except where used for color-coding.
- 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).
 - 4. Color: Black.
- 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.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- 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.
 - 2. Secure using [general-purpose] [UV-stabilized] [plenum-rated] cable ties.
- 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:

System Type	Conduit Color	Conduit Label	Box Covers
Emergency Power	Orange	Orange letters/white label	No color
Normal Power	No color	Black letter/white label	No color
Fire Alarm	Red	Red letters/white label	No color
Lighting Control	No color	Purple letters/white label	Purple
Communications	Blue	White letters/blue label	Blue
Fire Optic Cable	Green	Green letters/white label	No color
Building Automation Network (LAN)	White	Blue letters/white label	No color

- 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.
- L. Arc Flash Warning Labeling: Self-adhesive labels.
1. Comply with NFPA 70E and ANSI Z535.4.
 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:
 - 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.
- H. Single-Line Diagram: See "One-Line Diagram."

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

SECTION 260573 COORDINATION 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 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.
- I. Single-Line Diagram: See "One-Line Diagram."

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.
 - a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Short-Circuit Studies."
- 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] [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. 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 MG 1 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 over-current protective device settings.

END OF SECTION

SECTION 260574 ARC-FLASH HAZARD ANALYSIS

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.
- I. Single-Line Diagram: See "One-Line Diagram."

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.
 4. Arc-flash boundary.
 5. Restricted approach boundary.
 6. Limited approach boundary.
 7. Working distance.
 8. Incident energy.
 9. Hazard risk category.
 10. Recommendations for arc-flash energy reduction.
- 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.
 - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Short-Circuit Studies."
 - 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.
 - 1. Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
 - 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 260800 COMMISSIONING OF ELECTRICAL

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 (OPR), Basis of Design (BoD), and BoD-Electrical Systems Narrative documentation prepared by Owner and Architect contains requirements that apply to this Section.
- C. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Appendix 25 Section "General Commissioning Requirements". The commissioning process, which the Contractor is responsible to execute, is defined in Appendix 25 Section "General Commissioning Requirements". A Commissioning Authority (CxA) appointed by the Owner will direct the commissioning process.

1.2 SUMMARY

- A. This Section includes requirements for commissioning the electrical systems, subsystems and equipment. This Section supplements the general requirements specified in Appendix 25 Section "General Commissioning Requirements."
- B. Related Sections include the following:
 - 1. Appendix 25 Section "General Commissioning Requirements" for general requirements for commissioning processes that apply to this Section. The commissioning activities have been developed to support [Minnesota Buildings Benchmarks and Beyond (B3)], [Sustainable Building Guidelines and Zoning and Design Rules for the] [state Project name] to support delivery of project performance in accordance with the OPR developed with the approval of the Owner.

1.3 DEFINITIONS

- A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor.
- B. Design Team: Includes the architect plus consultant/design professionals responsible for design of fire suppression, plumbing, HVAC, controls for HVAC systems, electrical, communications, electronic safety and security, as well as other related systems.
- C. BoD: Basis of Design.
- D. BoD-Electrical: Electrical systems basis of design.
- E. CxA: Commissioning Authority.

- F. OPR: Owner's Project Requirements.
- G. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. Commissioning of a system or systems specified in this Division is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the CxA. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 Sections on Project Closeout and General Commissioning for substantial completion details and detailed commissioning requirements.
- B. List of electrical systems to be commissioned:

Normal Power Electrical Distribution Equipment
Emergency Lighting Systems
Emergency Power Electrical Distribution Equipment
Fire Alarm & Life Safety Systems
Plug-Load Control Systems
Occupancy Sensors
Lighting Controls
Day Lighting Controls

1.5 SUBMITTALS

- A. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 019113 "General Commissioning Requirements."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SYSTEMS READINESS CHECKLISTS

- A. System Readiness Checklists are part of the commissioning process. Systems Readiness Checklists provide documentation that systems, subsystems, and equipment are ready for functional testing. The Contractor shall complete the Systems Readiness Checklists for submission to the CxA and Owner. Refer to Section 019113 "General Commissioning Requirements" for further details.

3.2 CONTRACTORS TESTS

- A. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 019113 "General Commissioning Requirements" for further details.

3.3 FUNCTIONAL PERFORMANCE TESTING

- A. System functional performance testing is part of the Commissioning Process. Functional performance testing shall be performed by the contractor under the direction of the CxA. The CxA will witness and document the functional performance testing. Refer to Section 09113 "General Commissioning Requirements", for system functional performance testing and commissioning requirements.

3.4 OPERATIONS AND MAINTENANCE MANUALS

- A. General: The specific content and format requirements for the standard O&M manuals are detailed in Section 019113 "General Commissioning Requirements".
- B. CxA Review and Approval: Prior to substantial completion, the CxA shall review the O&M manual data, documentation and redlined as-builds for equipment and systems that were commissioned to verify compliance with the O&M documentation requirements of the specifications. The CxA shall communicate deficiencies in the manuals to the Owner. Upon a successful review of the corrections, the CxA shall recommend approval and acceptance of these sections of the O&M manuals to the Owner. The CxA shall also review each equipment warranty and verify that all requirements to keep the warranty valid are clearly stated. This work does not supersede the normal review requirement of the O&M manual data as indicated elsewhere in the specifications.

3.5 TRAINING OF OWNERS PERSONNEL

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 019113 "General Commissioning Requirements" and Division 26 Sections for additional contractor training requirements.

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.
- M. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.
- N. RS-485: A TIA standard for multipoint communications using two twisted-pairs.
- 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.
 6. Submit Specifications Performance Spread Sheet as identified in Part 3.9.

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.
 - 1. Match components and interconnections for optimum performance of specified functions.
- 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 LaboratoriesASCOSYSTEM
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.
 - 1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
 - 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 receipts 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 or 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.

Specifica- tion	Compliance F = Full P = Partial N = No	Variation	Submittal Refer- ence	Comments

END OF SECTION

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.
 - 3. Switchbox-mounted occupancy sensors.
 - 4. Wall dimmer occupancy sensors.
 - 5. Digital timer light switches.
 - 6. High-bay occupancy sensors.
 - 7. Wall-box dimmers.
 - 8. Emergency shunt relays.
- B. Related Requirements:
 - 1. Section 260523 "Control-Voltage Electrical Power Cables: For control cable requirements.
 - 2. Section 262726 "Wiring Devices" for manual light switches and non-networkable wall-switch occupancy sensors, and manual light switches.

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.
 3. Leviton Mfg. Company, 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.
 4. Leviton Mfg. Company, Inc.
 5. Lithonia Lighting; Acuity Lighting Group, Inc.
 6. Lutron Electronics Co., 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:
1. Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
 2. Dual technology.
 3. Integrated power pack.
 4. Hardwired connection to switch and 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.
 8. Power: Line voltage.
 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.
 5. Leviton Mfg. Company, 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 using hardwired connection.
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
 - 5. Leviton Mfg. Company, Inc.
 - 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.
 - 4. Color: White.
 - 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.
 - 4. Power: Line voltage.
 - 5. Operating Ambient Conditions: 32 to 149 deg F (0 to 65 deg C).
 - 6. Mounting: Threaded pipe.
 - 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.
 - 5. Leviton Mfg. Company 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."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. 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 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:
 - 1. Section 262726 "Wiring Devices" for manual light switches and non-networkable wall-switch occupancy sensors, and manual light switches.
 - 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.
 - 3. Ballasts and lamp combinations compatible with dimmers.
 - 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.

2. Leviton Mfg. Company Inc.
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.
 1. Panels: 6000 V, 3000 A, complying with IEEE C62.41.1 and IEEE C62.41.2.
 2. Other System Devices: 6000 V, 3000 A, complying with IEEE C62.41.1 and IEEE C62.41.2.
- 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. Laptop 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. BAS: Building automation system
- B. DDC: Direct digital control.
- C. IP: Internet protocol.
- D. 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.
 14. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
 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, caulk, 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.
 6. Connect all noted In-Room Networks to the Global Network for building-wide monitoring and management via PC-based Management Software and/or the building automation system (BAS). Provide optional Management Software for 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:
 - a. Sensitivity Adjustment, Time Delay, Detection Technology, and Walk-Through Mode.
 - 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, BAS, etc.
 - 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 astronomic 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 or BAS.
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 and BAS interface (optional).
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. BAS Integration
1. Provide capabilities for integration with a Building Automation System (BAS) via BACnet protocol.
 - a. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the Global Management Controller: Room occupancy state; Room schedule mode; Room switch lock control; Individual occupancy sensor state; Load ON/OFF state; Load dimming level; Panel relay state; and Global Management Controller Group schedule state.
- F. 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.
- A. Coordinate with Owner's IT Department to restrict external network access to Internet connected system through virtual private network (VPN) connections only.
- B. Disable any protocols for remote connectivity, unless constantly required for day-to-day operations.
- 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:
 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. Defense Security Service Office of the Designated Approving Authority – Master System Security Plan (MSSP) Template for Peer-to-Peer Networks (June 2011, Version 3.0).
 4. IEC 62443: Industrial Network and System Security

END OF SECTION

SECTION 261116.12

SECONDARY UNIT SUBSTATIONS WITH SWITCHBOARD SECONDARY

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 secondary unit substations, each consisting of medium-voltage primary incoming section, transformer section, and low-voltage secondary switchboard section, with the following features:
 - 1. Indoor enclosure.
 - 2. Medium-voltage, metal-enclosed switchgear section.
 - 3. Dry-type transformer.
- B. Related Requirements:
 - 1. Section 260513 "Medium-Voltage Cables" for requirements for terminating cables in incoming section of substation.
 - 2. Section 260572 "Short-Circuit Studies" for fault current ratings of equipment.
 - 3. Section 260573 "Coordination Studies" for settings of overcurrent protective devices.
 - 4. Section 263600 "Transfer Switches" for transfer switches that may be located in secondary distribution section.
 - 5. Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" for transient voltage surge suppressors for low-voltage power, control, and communication equipment that may be located in secondary section.

1.3 DEFINITIONS

- A. BIL: Basic insulation level.
- B. ICCB: Insulated-case circuit breaker.
- C. MCCB: Molded-case circuit breaker.
- D. NETA ATS: Acceptance testing specification.
- E. PCB: Polychlorinated biphenyl.
- F. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- 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.
 - 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. Wiring Diagrams: Power, signal, and control wiring.

8. Dimensioned plans and elevations showing major components and features.
 - a. Include a plan view and cross section of equipment base, showing clearances, manufacturer's recommended workspace that accounts for breaker service and removal, and locations of penetrations for grounding and conduits.
 9. One-line diagram.
 10. List of materials.
 11. Nameplate legends.
 12. The material, size and number of bus bars, and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
 13. Short-time and short-circuit current ratings of secondary unit substations and components.
 14. Ratings of individual protective devices.
- C. Time-Current Characteristic Curves: For overcurrent protective devices.
- D. Primary Fuses: Submit recommendations and size calculations.
- E. Refer to Section 018113 "Sustainable Design Requirements" for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings.
1. Indoor Installations:
 - a. Location plan, showing heavy equipment or truck access paths for maintenance and replacement.
 - b. Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.
 - c. Dimensioned concrete base, outline of secondary unit substation, conduit entries, and grounding equipment locations.
 - d. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways.
 - e. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.
- B. Qualification Data: For testing agency.
- C. Product Certificates: For secondary unit substations, signed by product manufacturer.
- D. Factory test reports.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For secondary unit substation(s) and accessories 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. Spare Fuses: Six of each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:
 - a. Primary disconnect fuses.
 - b. Potential transformer fuses.
 - c. Control power fuses.
 - d. Fuses and fusible devices for fused circuit breakers.
 - e. Fuses for secondary fusible devices.
 2. Spare Indicating Lights: Six of each type installed.
 3. Touchup Paint: Three half-pint containers of paint matching enclosure's exterior finish.
 4. Primary Switch Contact Lubricant: One container(s).
 5. One set(s) of spare mounting gaskets for bushings, handholes, and the gasket between relief cover and flange of pressure-relief device.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
- B. Coordinate delivery of secondary unit substations to allow movement into designated space.
- C. Store secondary unit substation components protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.
- D. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.10 FIELD CONDITIONS

- A. Service Conditions: The unit substation shall be suitable for operation under service conditions specified as usual service conditions in IEEE C37.121, except for the following:
 - 1. Exposure to significant solar radiation.
 - 2. Altitudes above 3300 ft. (1000 m).
 - 3. Exposure to fumes, vapors, or dust.
 - 4. Exposure to explosive environments.
 - 5. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
 - 6. Exposure to excessively high or low temperatures.
 - 7. Unusual transportation or storage conditions.
 - 8. Unusual grounding resistance conditions.
 - 9. Unusual space limitations.

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. ABB Control, Inc.
 - 2. Cooper Industries; Cooper Power Systems Division.
 - 3. Eaton Corporation; Electrical Sector.
 - 4. General Electric Company; Electrical Distribution & Control Products.
 - 5. Siemens Energy, Inc.
 - 6. Square D; a brand of Schneider Electric.

2.2 SYSTEM DESCRIPTION

- A. Description: Medium-voltage, primary incoming section; transformer section; and low-voltage secondary switchboard section; and including coordinated circuit breakers, fusible switches, and metering components.
 - 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 IEEE C2.
 - 3. Comply with IEEE C37.121.
 - 4. Comply with NFPA 70.

2.3 MANUFACTURED UNITS

- A. Indoor Unit Arrangement: Single assembly.

- B. Connections between the primary device and transformer shall be [cable] [bus], and between the transformer and secondary shall be flexible bus braid unless noted otherwise.
- C. Indoor Enclosure: Steel.
- D. Unit Substation Enclosures Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.

2.4 MEDIUM-VOLTAGE TERMINAL COMPARTMENT SECTION

- A. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters, complying with NEMA SG4 and meeting thermal, mechanical, and dielectric requirements specified for the transformer section.
- B. Ratings: Suitable for application in three-phase, 60-Hz, solidly grounded-neutral system.
- C. System Voltage: 13.8 kV nominal; 15 kV maximum.
- D. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.

2.5 MEDIUM-VOLTAGE METAL-ENCLOSED SWITCHGEAR SECTION

- A. Metal-enclosed, air-interrupter switchgear, with fuses, complying with IEEE C37.20.3.
 - 1. Switchgear shall be arc-resistant, complying with IEEE C37.20.7, [Type 1A] [Type 2A] [Type 1C] [Type 2C].
- B. Ratings: Comply with IEEE C37.04; and suitable for application in three-phase, 60-Hz, solidly grounded-neutral system.
 - 1. System Voltage: 13.8 kV nominal; 15 kV maximum.
 - 2. Design Level of Available-Source Fault Current: Integrated short-circuit rating consistent with value of fault current indicated.
 - 3. Main-Bus Rating: 600 A, continuous.
- C. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.
 - 1. Rating: 600-A continuous duty and load break.
 - 2. Two-Time Duty-Cycle Fault Closing: [25,000] [40,000] asymmetrical amperes.
 - 3. Switch Action: No external arc and no significant quantities of ionized gas released into the enclosure.
 - 4. Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
 - 5. Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
 - 6. Protective Shields: Cover live components and terminals.
 - a. Fuse Mounts: Single-frame mounted and de-energized when switch is open.
 - 7. Mechanical Interlock: Prevent opening switch compartment door unless switchblades are open, and prevent closing switch if door is open. Interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.
 - 8. Window: Permits viewing switch-blade positions when door is closed.
 - 9. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
- D. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading.
 - 1. *Current-Limiting Fuses: Full-range, fast-replaceable, current-limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.*
 - 2. *Expulsion Fuses: Furnished in disconnect-type mountings and renewable with replacement fuse units. Gases emitted on interruption are controlled and silenced by chambers designed for that purpose.*

3. Indicator integral with each fuse to show when it has blown.
 4. Spares: Include three fuses in use and three spare fuses in storage clips in each switch.
- E. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.

2.6 MEDIUM-VOLTAGE INSTRUMENTS SECTION

- A. Instrument Transformers: Comply with IEEE C57.13.
1. Potential and Current Transformers: Burden and Accuracy Class suitable for connected meters.
- B. Analog Instruments: Rectangular, 4-1/2 inches (115 mm) square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment.
1. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
 2. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase and phase-to-neutral voltages.
 3. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
 4. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
 5. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
 6. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, three phase, three wire; with three elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
 7. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.
 - a. Operation: Counts and records a succession of pulses entering two channels.
 - b. Housing: Drawout, back-connected case arranged for semiflush mounting.

2.7 DRY-TYPE TRANSFORMER SECTION

- A. Description: IEEE C57.12.01, [IEEE C57.12.50] [IEEE C57.12.51] [IEEE C57.12.52], and dry-type, two-winding, secondary unit substation transformer.
- B. Primary Incoming Section: Transformer cover-mounted bushings. The bushings shall meet thermal, mechanical, and dielectric requirements as specified for the transformer section.
- C. Style: Indoor, ventilated, cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
- D. Cooling System: Class AFA, forced-air cooling, complying with IEEE C57.12.01.
1. Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm-silencing relay.
 2. Include cooling fans.
- E. Insulation Materials: IEEE C57.12.01, rated 220 deg C.
1. Insulation Temperature Rise: 150 deg C, maximum rise above 40 deg C.
- F. BIL: [60] [75] [95] [110] kV.
- G. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, two above and two below rated primary voltage.
- H. Impedance: <Insert value> percent.
- I. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

2.8 SECONDARY DISTRIBUTION SECTION SWITCHBOARD

- A. The secondary distribution section shall be drawout, fused where indicated, low-voltage switchboard, complying with NEMA PB 2 and UL 891.
- B. Switchboard Structure: Front and rear accessible.
 - 1. Match and align the front and rear of the switchboard.
 - 2. Comply with UL requirements for service entrance equipment.
- C. Switchboard Bus:
 - 1. Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
 - 2. Main Phase Bus: Uniform capacity the entire length of section.
 - 3. Neutral Bus: 100 percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
 - 4. Vertical Section Bus: Extend to spaces for future circuit breakers.
 - 5. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
 - 6. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4-by-2 inches (6 by 50 mm).
 - 7. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
- D. Switchboard Arrangement:
 - 1. Main Disconnect Device(s): MCCBs.
 - 2. Feeder Protective Devices: MCCBs.
- E. MCCBs (to 2500 A): Fixed-mounted, manually operated air-circuit breakers. Comply with UL 489.
 - 1. With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by the position of the handle. With manual push-to-trip push button.
 - 2. Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
 - a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
 - b. With trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
 - c. Time-current adjustments to achieve protective-device coordination as follows:
 - 1) Adjustable long-time delay.
 - 2) Adjustable short-time setting and delay to shape the time-current curve.
 - 3) Adjustable instantaneous setting.
 - 4) Individually adjustable ground-fault setting and time delay.
 - d. With built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker. Provide one test set for testing the installed circuit breakers 225-ampere frame and higher.
 - e. With built-in digital ammeter display, showing load current and tripping cause.
- F. MCCBs (1600 to 2500 A): Fixed-mounted, manually operated air-circuit breakers. Comply with UL 489.
 - 1. With quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, and its position is shown by the position of the handle. With manual push-to-trip push button.
 - 2. Solid-state monitoring and tripping system to provide system status monitoring, adjustable time-current protection, and shunt trip.
 - a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
 - b. LED indicators or display, with manual reset, to show reasons of automatic trip.
 - c. Display panel to indicate that the status of the system circuitry is fully operational, or give fault location based on automatic diagnosis.
 - d. Trip the circuit breaker when closing on a fault.

- e. Time-current adjustments to achieve protective-device coordination as follows:
 - 1) Adjustable long-delay pickup and time.
 - 2) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
 - 3) Adjustable instantaneous pickup.
 - 4) Individually adjustable ground-fault pickup and time, with [I-squared-t setting] [ground alarm].
 - f. One test kit to test each trip function.
 - g. Battery backup for informational displays after automatic trip, with battery status indicator.
- G. Arc Energy Reduction
- 1. Provide for circuit breakers 1200A and larger with one of the following:
 - a. Short-Time and Ground Fault Zone Selective Interlocking to meet the requirements of NEC article 240.87 and 0.1 second coordination requirements.

2.9 LOW-VOLTAGE INSTRUMENTS SECTION

- A. Instrument Transformers: Comply with IEEE C57.13.
- 1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C 12.11 Accuracy Class of 0.3 with burdens of W, X, and Y.
 - 2. Current Transformers: Burden and Accuracy Class suitable for connected relays, meters, and instruments.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems.
- 1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
 - 2. Switch-selectable digital display with the following features:
 - 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. Three-Phase Real Power: Plus or minus 2 percent.
 - e. Three-Phase Reactive Power: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
 - i. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
 - 3. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements according to Section 260913 "Electrical Power Monitoring and Control."
 - 4. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.
- C. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.
- D. Surge Suppression: Factory installed as an integral part of the low-voltage switchboard, complying with UL 1449 SPD, Type 1, with the following features and accessories:
- 1. Integral disconnect switch.
 - 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - 3. Indicator light display for protection status.
 - 4. Form-C contacts rated at 5 A and 250-V ac, one N.O. and one N.C., for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - 5. Surge counter.
- E. Control Power Supply: Control power transformer supplying 120-V control circuits through secondary disconnect devices.

- F. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
 1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
 2. Conductors sized according to NFPA 70 for duty required.
- G. Maintenance Tools: Furnish tools and miscellaneous items required for circuit-breaker and switchboard test, inspection, maintenance, and operation.
 1. Racking handle to manually move circuit breaker between "connected" and "disconnected" positions.
 2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchboard.
 3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
 4. Circuit-Breaker Removal Apparatus: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.
 5. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
 6. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

2.10 IDENTIFICATION DEVICES

- A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.11 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to NEMA C37.51.
- B. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:
 1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
 2. Ratios on the rated voltage connection and on tap extreme connections.
 3. Polarity and phase relation on the rated voltage connection.
 4. No-load loss at rated voltage on the rated voltage connection.
 5. Exciting current at rated voltage on the rated voltage connection.
 6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
 7. Applied potential.
 8. Induced potential.
 9. Temperature Test: If a transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kVA Class ONAN or Class AA rating and highest kVA Class ONAF or Class AFA rating.
 - a. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of the Work.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.

- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.
- D. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at secondary unit substation location.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with applicable portions of NECA 1, NECA 400, NECA 410, NECA 430, and NEMA SG 11.
- B. Install secondary unit substations on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Install the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 ft. (9 m) apart.
 - 2. Install arc-flash warning labels specified in Section 260573.19 "Overcurrent Protective Device Arc-Flash Study."
- B. Operating Instructions: Place printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures with the maintenance materials.

3.4 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. At Interior Locations: For grounding to grounding electrodes, use bare copper cable not smaller than No. 4/0 AWG. Bond surge arrester and neutrals directly to the transformer enclosure and then to the grounding electrode system with bare copper conductors. Keep leads as short as practicable with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
 - 2. At Exterior Locations:
 - a. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than 30 inches (765 mm) below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals shall directly to the transformer enclosure and then to the grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable with no kinks or sharp bends.
 - b. Fence and equipment connections shall not be smaller than No. 4 AWG. Ground fence at each gate post and corner post and at intervals not exceeding 10 ft. (3050 mm). Bond each gate section to the fence post using 1/8 by 1 inch (3 by 25 mm) [tinned] flexible braided copper strap and clamps.
 - c. Make joints in grounding conductors and loops by exothermic weld or compression connector.
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 CLEANING

- A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

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:
- C. General Field Testing Requirements:
 - 1. Comply with the provisions of NFPA 70B Ch. "Testing and Test Methods."
 - 2. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
 - 3. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation is tested at the specified value or less.
 - 4. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
 - 5. Visual and Mechanical Inspection:
 - a. Verify equipment nameplate data complies with Contract Documents.
 - b. Inspect bolted electrical connections for high resistance using one of the following two methods:
 - 1) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate 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 according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
 - 6. Remove and replace malfunctioning units and retest.
 - 7. Prepare test and inspection reports. Record as-left set points of all adjustable devices.
- D. Switchboard Field Tests:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and required area clearances.
 - c. Verify the unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
 - d. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study as well as the address of the circuit breaker that is used to identify it in microprocessor-communication software.
 - e. Verify that current and voltage-transformer ratios correspond to Drawings.
 - f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
 - 1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
 - 2) Make key exchange with devices operated in off-normal positions.
 - g. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - h. Inspect insulators for evidence of physical damage or contaminated surfaces.
 - i. Verify correct barrier and shutter installation and operation.
 - j. Exercise all active components.
 - k. Inspect mechanical indicating devices for correct operation.
 - l. Verify that filters are in place and vents are clear.
 - m. Inspect control power transformers as follows:
 - 1) Inspect for physical damage, cracked insulation, broken leads, connection tightness, defective wiring, and overall general condition.
 - 2) Verify that primary- and secondary-use or circuit-breaker ratings match Drawings and comply with manufacturer's recommendations.
 - 3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.
 - 2. Electrical Tests:

- a. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg. C, adjust the resulting resistance as provided in NETA ATS Table 100.11.
 - 1) Insulation-resistance values of bus insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
 - 2) Do not proceed to the dielectric-withstand-voltage tests until insulation-resistance levels are raised above minimum values.
 - b. Perform a dielectric-withstand-voltage test on each bus section, each phase-to-ground with phases not under test grounded, according to manufacturer's published data. If manufacturer has no recommendation for this test, it shall be conducted according to NETA ATS, Table 100.2. Apply the test voltage for one minute.
 - 1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.
 - c. Voltage Transformers:
 - 1) Perform secondary wiring integrity test. Verify correct potential at all devices.
 - 2) Verify secondary voltages by energizing the primary winding with system voltage.
 - d. Perform current-injection tests on the entire current circuit in each section of switchgear.
 - 1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
 - 2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
 - e. Verify operation of space heaters.
 - f. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.
- E. Medium-Voltage Surge Arrester Field Tests:
- 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify the arresters are clean.
 - d. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
 - e. Verify that the stroke counter is correctly mounted and electrically connected if applicable. Record the stroke counter reading.
 - 2. Electrical Test:
 - a. Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in the table.
 - b. Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.
- F. Instrument Transformer Field Tests:
- 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Verify correct connection of transformers with system requirements.
 - c. Verify that adequate clearances exist between primary and secondary circuit wiring.
 - d. Verify the unit is clean.
 - e. Verify that all required grounding and shorting connections provide contact.
 - f. Verify correct operation of transformer withdrawal mechanism and grounding operation.
 - g. Verify correct primary- and secondary-fuse sizes for voltage transformers.
 - h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:
 - a. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1000-V dc for one minute. For units with solid-state components that cannot tolerate the applied voltage, comply with manufacturer's recommendations. Insulation-resistance values of instrument transformers shall not be less than values shown in NETA ATS, Table 100.5.
 - b. Perform a polarity test of each current transformer according to IEEE C57.13.1. Polarity results shall agree with transformer markings.
 - c. Perform a ratio-verification test using the voltage or current method according to IEEE C57.13.1. Ratio errors shall comply with IEEE C57.13.
 - d. Perform an excitation test on transformers used for relaying applications according to IEEE C57.13.1. Excitation results shall match the curve supplied by the manufacturer or shall comply with IEEE C57.13.1.
 - e. Measure current circuit burdens at transformer terminals according to IEEE C57.13.1. The measured burdens shall match the instrument transformer Accuracy Class rating.
 - f. Perform insulation-resistance tests on the primary winding with the secondary grounded. Test voltages shall comply with NETA ATS, Table 100.5. The insulation-resistance value shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
 - g. Perform dielectric-withstand-voltage tests on the primary winding with the secondary grounded. Test voltages shall comply with NETA ATS, Table 100.9. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application, the primary winding is considered to have passed the test.
 - h. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data. Power-factor or dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with test equipment manufacturer's published data.
 - i. Verify that current-transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3.
3. Electrical Tests of Voltage and Potential Transformers:
 - a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply the test voltage for one minute according to NETA ATS, Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations. Insulation-resistance values of instrument transformers shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
 - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Test voltages shall be applied for one minute according to NETA ATS, Table 100.5. Insulation-resistance values of the transformers shall not be less than values shown in NETA ATS, Table 100.5
 - c. Perform a polarity test on each transformer to verify the polarity marks or H(1)- X(1) relationship. Polarity results shall agree with transformer markings.
 - d. Perform a turns-ratio test on all tap positions. Ratio errors shall not exceed the tolerances specified in IEEE C57.13.
 - e. Measure voltage circuit burdens at transformer terminals. Measured burdens shall be compared to instrument transformer ratings. The measured burdens shall match the instrument transformer Accuracy Class rating.
 - f. Perform a dielectric-withstand-voltage test on the primary windings with the secondary windings connected to ground. The dielectric voltage shall comply with NETA ATS, Table 100.9. The test voltage shall be applied for one minute. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the primary windings are considered to have passed the test.
 - g. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data. Power-factor or dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with test equipment manufacturer's published data.
 - h. Verify that voltage-transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3.

G. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:
 - a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
 - b. Verify operation of light-emitting diodes, display, and targets.
 - c. Record passwords for each access level.
 - d. Clean the front panel and remove foreign material from the case.
 - e. Check tightness of connections.
 - f. Verify that the frame is grounded according to manufacturer's instructions.
 - g. Set the relay according to results in Section 260573 "Coordination Studies" and in Section 260574 "Arc-Flash Hazard Analysis."
 - h. Download settings from the relays. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.
2. Electrical Tests:
 - a. Perform insulation-resistance tests from each circuit to the grounded frame according to manufacturer's published data.
 - b. Apply voltage or current to all analog inputs, and verify correct registration of the relay meter functions.
 - c. Functional Operation: Check functional operation of each element used in the protection scheme.

H. Dry-Type Transformer Section 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. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
 - f. Verify that cooling fans operate and that fan motors have correct overcurrent protection.
 - g. Perform specific inspections and mechanical tests recommended by the manufacturer.
 - h. Verify that as-left tap connections are as specified.
 - i. Verify the presence of surge arresters and that their ratings are as specified.
2. Electrical Tests:
 - a. 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.
 - b. Perform power-factor or dissipation-factor tests on all windings according to the test equipment manufacturer's published data. Investigate and correct power-factor values that exceed:
 - 1) 2.0 percent for power transformers.
 - 2) 5.0 percent for distribution transformers.
 - 3) Measure core insulation resistance at 500 V dc if the core is insulated and the core ground strap is removable. Core insulation-resistance values shall not be less than 1 megohm at 500-V dc.
 - c. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV. Tip-up test result exceeding 1.0 percent shall be investigated.
 - d. Perform turns-ratio tests at all tap positions. The test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If the test fails, replace the transformer.
 - e. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if the test shows a different pattern.
 - f. Measure the resistance of each winding at each tap connection.

- g. 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. The ac dielectric-withstand-voltage test result shall not exceed 75 percent of factory test voltage for one-minute duration. The dc dielectric-withstand-voltage test result shall not exceed 100 percent of the ac rms test voltage specified in IEEE 57.12.91, Section 10.2, for one-minute duration. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.
 - h. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- I. Low-Voltage Power Circuit-Breaker Field Tests:
- 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that all maintenance devices are available for servicing and operating the breaker.
 - d. Verify the unit is clean.
 - e. Verify that the arc chutes are intact.
 - f. Inspect moving and stationary contacts for condition and alignment.
 - g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
 - h. Perform mechanical operator and contact alignment tests on both the breaker and its operating mechanism according to manufacturer's published data.
 - i. Verify cell fit and element alignment.
 - j. Verify racking mechanism operation.
 - k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - l. Perform adjustments for final protective-device settings according to coordination study provided by end user.
 - m. Record as-found and as-left operation counter readings.
 - 2. Electrical Tests:
 - a. 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 according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.
 - b. Measure contact resistance across each power contact of the circuit breaker. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - c. Determine long-time pickup and delay by primary current injection. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS, Table 100.7.
 - d. Determine short-time pickup and delay by primary current injection. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
 - e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
 - f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
 - g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic shall be as specified and within manufacturer's published tolerances.

- h. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall conform to the manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
 - i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - j. Verify correct operation of any auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip unit battery condition. Reset all trip logs and indicators. Auxiliary features shall operate according to manufacturer's published data.
 - k. Verify operation of charging mechanism. The charging mechanism shall operate according to manufacturer's published data.
- J. Insulated-Case/Molded-Case Air-Circuit-Breaker Field Tests:
1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage and alignment.
 - c. Verify the unit is clean.
 - d. Operate the circuit breaker to ensure smooth operation.
 - e. Inspect operating mechanism, contacts, and arc chutes in unsealed units.
 - f. Perform adjustments for final protective-device settings according to the coordination study. Set the protective devices according to results in Section 260573 "Coordination Studies" and in Section 260574 "Arc-Flash Hazard Analysis."
 2. Electrical Tests:
 - a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.
 - b. Perform a contact/pole-resistance test. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - c. Determine long-time pickup and delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band, including adjustment factors.
 - d. Determine short-time pickup and delay by primary current injection. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
 - e. Determine ground-fault pickup and time delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
 - f. Determine instantaneous pickup by primary current injection. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
 - g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic shall be as specified and within manufacturer's published tolerances.
 - h. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall conform to the manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
 - i. Verify correct operation of auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, anti-pump function, and trip unit battery condition. Reset all trip logs and indicators. Auxiliary features shall operate according to manufacturer's published data.

- j. Verify operation of charging mechanism. The charging mechanism shall operate according to manufacturer's published data.
- K. Low-Voltage Ground-Fault Protection System Field Tests:
- 1. Visual and Mechanical Inspection:
 - a. Inspect the components for damage and errors in polarity or conductor routing.
 - 1) Verify that ground connection is made on the source side of the neutral disconnect link and on the source side of any ground-fault sensor.
 - 2) Verify that the neutral sensors are connected with correct polarity on both primary and secondary.
 - 3) Verify that phase conductors and the neutral pass through the sensor in the same direction for zero sequence systems.
 - 4) Verify that grounding conductors do not pass through zero sequence sensors.
 - 5) Verify that grounded conductor is solidly grounded.
 - b. Verify the unit is clean.
 - c. Operate the circuit breaker to ensure smooth operation.
 - d. Verify correct operation of functions of the self-test panel if provided.
 - e. Verify that the control power transformer has adequate capacity for the system.
 - f. Set pickup and time-delay settings according to "Quality Control" Article. Record appropriate operation and test sequences according to NFPA 70, "Services" Article, "Ground-Fault Protection Equipment" Section.
 - 2. Electrical Tests:
 - a. Measure the system neutral-to-ground insulation resistance with the neutral disconnect link temporarily removed. Replace the neutral disconnect link after testing. System neutral-to-ground insulation resistance shall be a minimum of 1 megohm. Correct wiring until the minimum is achieved.
 - b. Perform ground-fault protective-device pickup tests using primary injection. Results of pickup test shall be greater than 90 percent of the ground-fault protective-device pickup setting and less than 1200 A or 125 percent of the pickup setting, whichever is smaller. Adjust or replace the device until these parameters are achieved.
 - c. For summation-type systems utilizing phase and neutral current transformers, verify correct polarities by applying current to each phase-neutral current-transformer pair. This test also applies to MCCBs utilizing an external neutral current transformer. The ground-fault protective device shall operate when current direction is the same relative to polarity marks in the two current transformers. The ground-fault protective device shall not operate when current direction is opposite relative to polarity marks in the two current transformers.
 - d. Measure time delay of the ground-fault protective device at a value equal to or greater than 150 percent of the pickup value. Relay timing shall be according to manufacturer's published data but shall be no longer than one second at 3000 A according to NFPA 70, "Services" Article, "Ground-Fault Protection Equipment" Section.
 - e. Verify reduced control voltage tripping capability is 55 percent for ac systems and 80 percent for dc systems. Replace the ground-fault system if the reduced control voltage tripping requirement is not achieved, and retest.
- L. Metering Device Field Tests:
- 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
 - c. Verify the unit is clean.
 - d. Verify freedom of movement, end play, and alignment of rotating disk(s).
 - 2. Electrical Tests:
 - a. Verify accuracy of meters at all cardinal points. Meter accuracy shall be according to manufacturer's published data.
 - b. Calibrate meters according to manufacturer's published data. Calibration results shall be within manufacturer's published tolerances.
 - c. Verify all instrument multipliers. Instrument multipliers shall be according to system design specifications.

- d. Verify that current-transformer and voltage-transformer secondary circuits are intact. Test results shall confirm the integrity of the secondary circuits of current and voltage transformers.

3.7 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Adjust transformer taps.
 - b. Rebalance loads.
 - c. Prepare written request for voltage adjustment by electric utility.
 3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
 4. Report:
 - a. Prepare a written report covering monitoring performed and corrective action taken.
 - b. For each relay and adjustable circuit breaker, tag the device with adjusting technician's initials and the date of the adjustment. Record the settings and file with test records specified in "Field Quality Control" Article.
- B. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.
 1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of the unit substation.
 2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
 3. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1deg.C at 30deg.C.
 4. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the results as follows:
 - a. Description of equipment to be tested.
 - b. Discrepancies.
 - c. Temperature difference between the area of concern and the reference area.
 - d. Probable cause of temperature difference.
 - e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
 - f. Identify load conditions at time of inspection.
 - g. Provide photographs and thermograms of the deficient area.
 5. Act on inspection results according to the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.

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
 3. Eaton Electrical Inc.; Cutler-Hammer Products.
 4. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
 5. General Electric Company.
 6. Hammond Co.; Matra Electric, Inc.
 7. Marcus Transformer LTD
 8. MGM Transformer Company
 9. Micron Industries Corporation
 10. Mirus International Inc.
 11. Siemens Energy & Automation, 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.
 4. K-13 rating.
- 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

SECTION 262413 SWITCHBOARDS

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).
 3. National Fire Protection Association (NFPA):
 - 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.
 10. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 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).
 - b. 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. 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, bus-work, 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.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 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.
 - 2. Branch Devices: Panel mounted.
 - 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.
 - 1. Space-Heater Control: Manual switching of branch-circuit protective device.
 - 2. Space-Heater Power Source: 120-V external branch circuit.
- 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-resistive 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.
 - 2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated circuit-breaker line connections.
 - 3. Copper feeder circuit-breaker line connections.
 - 4. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
 - 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.
 - 8. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- 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.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

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).
 7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-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 inter-connections 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.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 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. Altitude: Not exceeding 6600 feet (2000 m).
- 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.
 6. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- 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:
1. Material: Hard-drawn copper, 98 percent conductivity.
 - 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.
1. Material: Hard-drawn copper, 98 percent conductivity.
 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.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.
 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.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- 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.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 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 OVERCURRENT 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.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 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.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 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).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
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.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Communication Capability (where identified on drawings or schedules): 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."
 - h. Shunt Trip (where identified on drawings or schedules): 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
 - k. Auxiliary Contacts (where identified on drawings or schedules): One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - l. Alarm Switch (where identified on drawings or schedules): Single-pole, normally open contact that actuates only when circuit breaker trips.
 - m. Key Interlock Kit (where identified on drawings or schedules): Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - n. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - o. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
 - p. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
 - q. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

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 equipment 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 INTERGRATED 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 responsibility 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 Architect.

3.3 INSTALLATION

- A. Coordinate layout and installation of panelboards 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. 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 temporary blocking of moving parts from panelboards.
- F. Mount top of trim at a maximum of 90 inches (2286 mm) above finished floor unless otherwise indicated. 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 recommended 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.
 - 9. Prefabricated multioutlet assemblies.

1.3 DEFINITIONS

- A. Abbreviations of Manufacturers' Names:
 - 1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
 - 2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
 - 3. Leviton: Leviton Mfg. Company, Inc.
 - 4. Pass & Seymour: Pass& Seymour/Legrand.
- 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).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand (Pass & Seymour).

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:
 - a. Eaton SGF20.
 - 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.
 2. Hubbell: SNAPConnect 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.
 3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
 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.
 3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

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:
 - a. Eaton; 1995.
 - 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.
 2. Wiring Devices Connected to Emergency Power System: Red.
 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).
 - 6. Molded-case switches.
 - 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).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).

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.
 - 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 4. Siemens Energy & Automation, Inc.
 - 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.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
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.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 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-circuit 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.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 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.
- I. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- J. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

- 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 I²t 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. Investigate 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 Specifications 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 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. Measure contact resistance across each switchblade fuseholder. 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.
- 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 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.
- 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. Investigate 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.
 - 7. Vibration isolation devices.
 - 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.
 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
 4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 5. Report of sound generation.
 6. Report of exhaust emissions showing compliance with applicable regulations.
 7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- 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.
 - 5. Onan/Cummins Power Generation; Industrial Business Group.
- 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:
 - 1. Comply with NFPA 37.
 - 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.
 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.
 - 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.
 8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 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.
- d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
- 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.
 - 3. Manual Fuel Shutoff Valves: 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.
 - b. Run-Off-Auto switch.
 - 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.
- p. Coolant low-temperature alarm.
- q. Coolant high-temperature shutdown device.
- r. EPS load indicator.
- s. Battery high-voltage alarm.
- t. Low-cranking voltage alarm.
- 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.
- aa. Remote manual-stop shutdown device.
- bb. Air shutdown damper alarm when used.
- cc. Air shutdown damper shutdown device when used.
- dd. Generator overcurrent-protective-device not-closed alarm.
- ee. 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.
- 11. Audible-alarm silencing switch.
- 12. Air shutdown damper when used.
- 13. Run-Off-Auto switch.

- 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.
 - 1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 - 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.
 - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Stormproof and drainable louvers prevent entry of rain and snow.
 - 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.
 - 1. Material: Standard neoprene separated by steel shims.
 - 2. Shore A Scale Durometer Rating: 50.
 - 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.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
 - 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.
 - 6. Voltage regulation.
 - 7. Transient and steady-state governing.
 - 8. Single-step load pickup.
 - 9. Safety shutdown.
 - 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 231123 "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.
 - 10. Detail short-circuit current rating of connection cabinet.
 - 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).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- 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 213213 "Electric-Drive, Vertical-Turbine Fire Pumps" for automatic transfer switches for fire pumps.
 - 3. 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] [30] <Insert number> 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.
- L. Manual Switch Operation: Unloaded. 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.
 - 6. Ground-Fault Protection: Comply with UL 1008 for normal and alternative buses.
 - 7. Service Disconnecting Means: Externally operated, manual mechanically actuated.
- 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. Generac Power Systems, Inc.
 - g. General Electric Company
 - h. Hubbell Power Systems, Inc.
 - i. Kohler Power Systems; Generator Division.
 - j. MTU On Site Energy.
 - k. Russelectric, Inc.
- 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.
 5. Material: [Tin-plated aluminum] [Hard-drawn copper, 98 percent conductivity].
 6. Main and Neutral Lugs: [Compression] [Mechanical] type.
 7. Ground Lugs and Bus-Configured Terminators: [Compression] [Mechanical] type.
 8. Ground bar.
 9. Connectors shall be marked for conductor size and type according to UL 1008.
 10. <Insert features>.
- 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.
- H. Manual Switch Operation: Unloaded. 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 drop-out 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.
 - 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
 - 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.
 - l. 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 requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 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 recommended 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. Conceal 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 Cables."
- 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 Cabling."
- H. Route and brace conductors according to manufacturer's written instructions[.] and Section 260529 "Hangers and Supports for Electrical Systems."] Do not obscure manufacturer's markings and labels.
- I. Brace and support equipment according to Section 260548 "Seismic Controls for Electrical Systems."
- J. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches (457 mm) in length.
- K. Provide all necessary connections between automatic transfer switches.
- L. Provide all necessary connections between automatic transfer switches and generator(s).
- M. 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 representative:
 - 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 methods, 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 connections, 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 acceptable 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.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
- 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.
6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
- 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 T_s 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 T_s 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.

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%.
 7. Drivers must comply with FCC 47 CFR Part 15 non-consumer RFI/EMI standards.
 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 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.
- 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. 1. Manufacturer's standard grade.
 - 2. 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 luminaires. 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.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 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.
- 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

SECTION 265201 INTERIOR 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. 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)
- 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.
 - 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. LED 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. 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.
- J. Closeout Submittals
1. Coordinate with Division 01 – Execution Requirements.
- K. Operation and Maintenance Data
1. Coordinate with Division 01 – Facility Operation.
- L. 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. Spinings 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 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.

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 80.

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

DECORATIVE PENDANT IN HILBERRY
GATEWAY LOBBY

ALLOW \$800 CONTRACTOR NET PER
PENDANT

ALLOWANCE DOES NOT INCLUDE
CONTRACTOR MARKUP,
TAXES OR SHIPPING

ONE

TYPE **L20, L20A**

AUERBACH·GLASOW

LA2

SPECIFICATIONS



ONE

As shown

STANDARD DIMENSIONS

Custom options available

SMALL

22" Dia x 4"H - 14 lbs

22" Dia x 8"H - 15 lbs

22" Dia x 12"H - 16 lbs

MEDIUM

30" Dia x 4"H - 19 lbs

30" Dia x 8"H - 20 lbs

30" Dia x 12"H - 22 lbs

LARGE

44" Dia x 4"H - 30 lbs

44" Dia x 8"H - 32 lbs

44" Dia x 12"H - 33 lbs

MATERIALS

*1/16" 3form Varia EcoResin
White Opal diffuser*

LA2 One Medium 4"H in Hush Masala

LIGHTING

Solid State LED System

120v-277v input;
0-10v dimming compatible

3000k, 3500k or 4000k options
81 CRI light source
(Small available in 3000k only)

S - 34w
LED Lumens 2405

M - 82w
LED Lumens 6063

L - 116w
LED Lumens 9310

HARDWARE

Removable powder coated lid

Canopy and dress plate mounts to
standard junction box (provided by others)

Surface mount option available

Small/Medium canopy: 8" Dia
Large canopy: 9" Dia

3/64" stainless steel cables to ceiling

Adjustable 24"-96" suspension

White power cord to canopy

STANDARDS

4-6 week lead time

CSA Approved to UL standards

250+ 3form material options

Damp Rated

5 year limited warranty

Contact for custom material pricing



Last Update: 4.16.18



4770 OHIO AVE SOUTH, SUITE A
SEATTLE, WA 98134
lightart.com

ONE

TYPE L20,A

AUERBACH · GLASOW

LA2

SPECIFICATIONS

SMALL



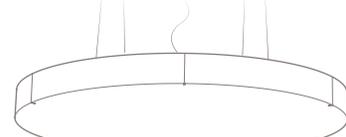
22" DIA x 4" H - 14 LBS

MEDIUM



30" DIA x 4" H - 19 LBS

LARGE



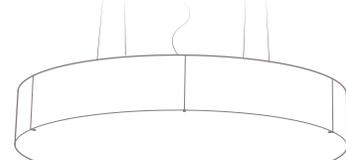
44" DIA x 4" H - 30 LBS



22" DIA x 8" H - 15 LBS



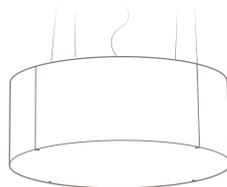
30" DIA x 8" H - 20 LBS



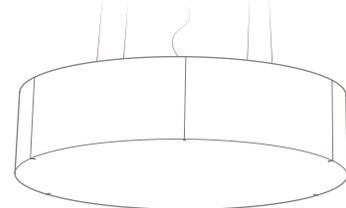
44" DIA x 8" H - 32 LBS



22" DIA x 12" H - 16 LBS



30" DIA x 12" H - 22 LBS



44" DIA x 12" H - 33 LBS

STOCK SHADE MATERIALS

3form Varia Ecoresin / 4-6 week lead time



Cinder Natural Gesso Mid Century Rosewood Silken Oyster Wizard Cranberry Vitamin C x2

*Materials shown lit (left) and unlit (right)

*Due to manufacturing and construction process used to create the Essentials and Connected collection, Pattern+ and wood grains will not match at fixture seams.

*Lead times subject to change

MATERIAL OPTIONS

Hundreds of colors available!

Contact us for samples and more information.

CANOPY & DRESS PLATE FINISH OPTIONS

White Canopy & White Dress Plate standard



White/ White

Black/Stainless Steel Silver/Silver Black/Black Steel

BY REQUEST

POWER CORD COLOR OPTIONS

White Power Cord Standard



White



Silver



Black

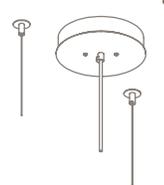
BY REQUEST

*Silver not available for Large size

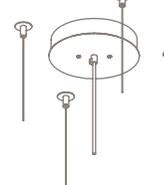
CEILING HARDWARE

Cables to Ceiling

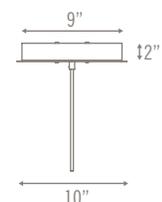
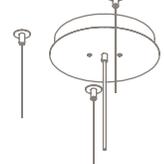
SMALL



MEDIUM



LARGE





Gotham Architectural Downlighting
LED Downlights

**2" Incito®
Downlight**

Solid-State Lighting
(US and International Patents Pending)



FEATURES

OPTICAL SYSTEM

- Superior 100% virgin silicone refractive optic enables maximum dimensional stability and optical transmission with no discoloration over life.
- Primary control of distribution occurs in refractive optic allowing for aesthetic versatility with trim color and finish.
- 2.5-step MacAdam Ellipse.
- Thirteen preset distribution patterns allow designers to achieve tailored effects.
- Self-flanged semi-specular or matte-diffuse lower trim.
- Field interchangeable optics.
- 35° shielding angle to refractive optics.

MECHANICAL SYSTEM

- Install from below architecture standard.
- Several additional mounting options available including a structural reinforcement pan, Chicago plenum, and Type IC.
- Standard ambient operating temperature: 25 °C. High ambient option available.
- Accommodates a wide range of applications including multiple plenum cross sections and ceiling thicknesses. Consult page 2.
- Light engine and driver are accessible from above or below ceiling.
- Flangeless trim option includes proprietary Gotham mud ring enabling seamless integration into drywall applications. Mud ring ships separately.

ELECTRICAL SYSTEM

- Solid-state LED light engine available in 2700 K, 3000 K, 3500 K or 4000 K color temperatures. Standard CRI: 80 typical. High CRI option available.
- Rated system life of >60,000 hours at 70% output.
- 120V TRIAC or ELV dimming and 0-10V dimming standard.
- Luminaire accepts parallel and branch circuit control wiring.

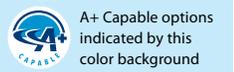
LISTINGS

- Fixtures are UL listed to meet US and Canadian standards; wet location, covered ceiling.
- ENERGY STAR® certified product.

WARRANTY

- 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C.



EXAMPLE: **IC0 35/10 2AR LSS 20D MVOLT UGZ**

Series	Color temperature	Nominal lumen values	Aperture/Trim color	Trim Style	Finish	Beam
IC0	27/ 2700 K	05 500 lumens	2AR Clear	(blank) Self-flanged	LSS Semi-specular	15D 15° beam angle
	30/ 3000 K	07 750 lumens	2PR Pewter			20D 20° beam angle
	35/ 3500 K	10 1000 lumens	2WTR Wheat	FL Flangeless	LD Matte diffuse	25D 25° beam angle
	40/ 4000 K	15¹ 1500 lumens	2GR Gold			30D 30° beam angle
			2WR² White			35D 35° beam angle
			2BR² Black			40D 40° beam angle
						45D 45° beam angle
						50D 50° beam angle
						55D 55° beam angle
						3515D Elliptical 35° x 15° beam angle
			5020D Elliptical 50° x 20° beam angle			
			5060D Elliptical 50° x 60° beam angle			
			6070D Elliptical 60° x 70° beam angle			

ORDERING INFORMATION

Voltage	Driver	Options
MVOLT³ 120 277 347⁴	UGZ⁵ Universal dimming to 1% (0-10V, 120V TRIAC or ELV)	SF^{5,6} Single fuse TRW^{7,8} White painted flange TRBL^{8,9} Black painted flange CP¹ Chicago plenum NPP16D^{5,6,10} nLight® network power/relay pack with 0-10V dimming. NPP16DER^{5,6,10} nLight® network power/relay pack with 0-10V dimming. ER control fixtures on emergency circuit.
		CR190 High CRI (90+) HAO¹ High ambient (40°C) ICAT¹ IC/Airtight housing construction NCH Structural reinforcement pan **Remotely located eldoLED dimming driver**

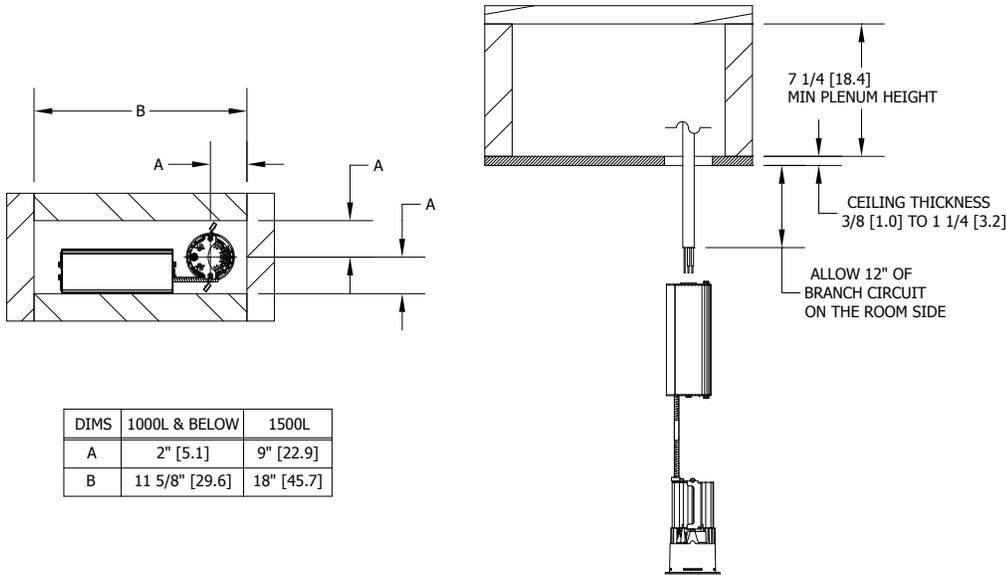
ACCESSORIES order as separate catalog numbers (shipped separately)

OPTC2¹¹ Additional optics available for field installation	HS258 2-5/8" Hole saw
OPTC2 KIT Kit including a field interchangeable optic for each of the 13 preset beam distribution patterns	HS234FL 2-3/4" Hole saw for flangeless trim option

DIMENSIONAL DATA

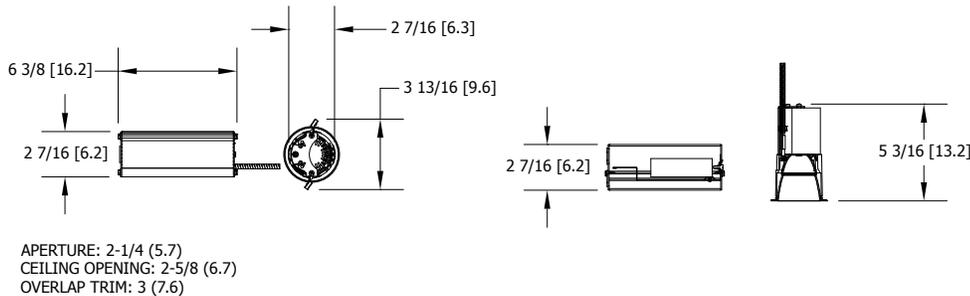
All dimensions are inches (centimeters) unless otherwise noted.

RECESSED APPLICATION — MINIMUM CLEARANCE REQUIREMENTS

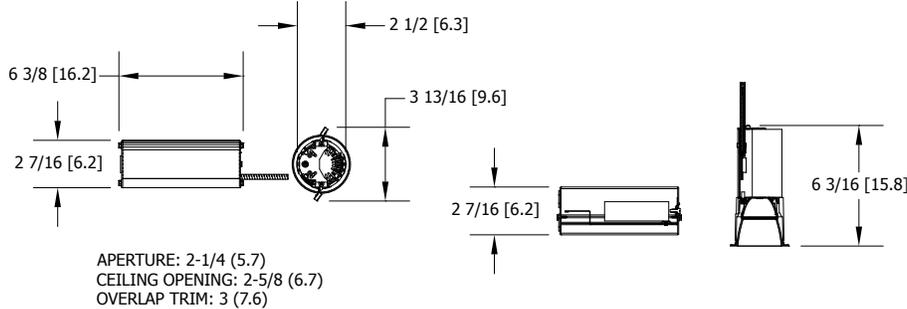


DIMS	1000L & BELOW	1500L
A	2" [5.1]	9" [22.9]
B	11 5/8" [29.6]	18" [45.7]

500, 750, AND 1000 LUMEN INSTALL-FROM-BELOW CONSTRUCTION



1500 LUMEN OR AMBIENT OPTION INSTALL-FROM-BELOW CONSTRUCTION



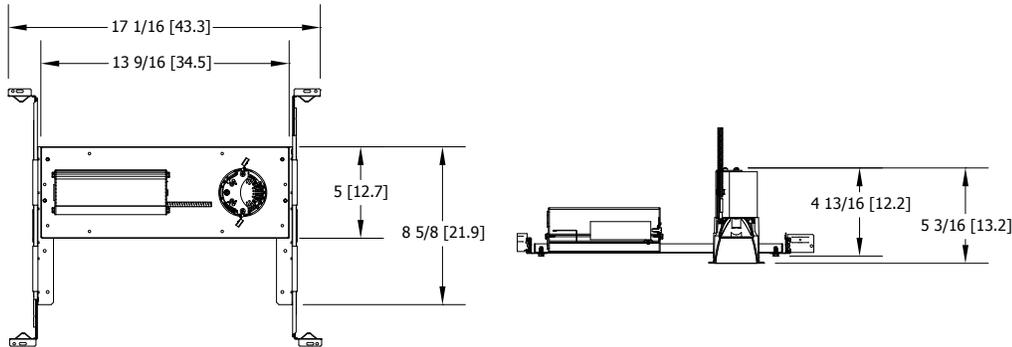
NOTES

ORDERING NOTES

- 1500lm not available with CP, ICAT, or HAO.
- Not available with finishes.
- Multi-volt 120-277V.
- Device must be remote mounted. Will not be factory installed. Access required to location of remote mounted device.
- Refer to [TECH SHEET 240](#) for full list of recommended compatible dimmers. Control system electrical load, and protocol may limit minimum dim level.
- Must specify 120, 277, or 347V.
- Not specifiable with WR reflector.
- Not available with flangeless (FL) trim style.
- Not specifiable with BR reflector.
- Access to nPod necessary for servicing.
- Must specify desired optical distribution from available options in "Beam" column. i.e. OPTC2 15D or OPTC2 3515D. Includes additional capture rings.

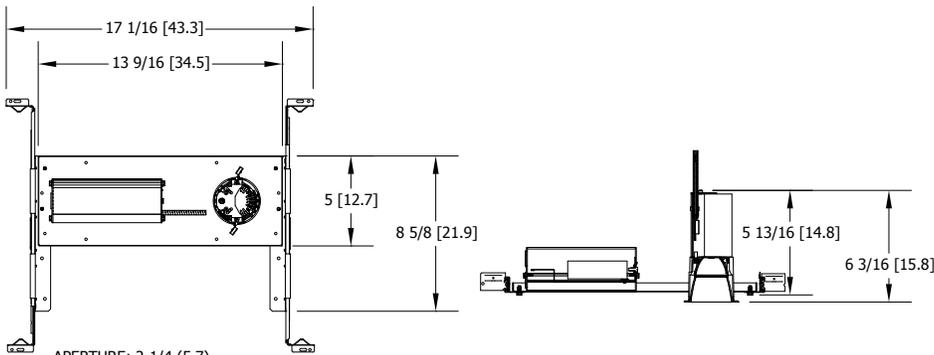
All dimensions are inches (centimeters) unless otherwise noted.

500, 750, AND 1000 LUMEN STRUCTURAL REINFORCEMENT PAN



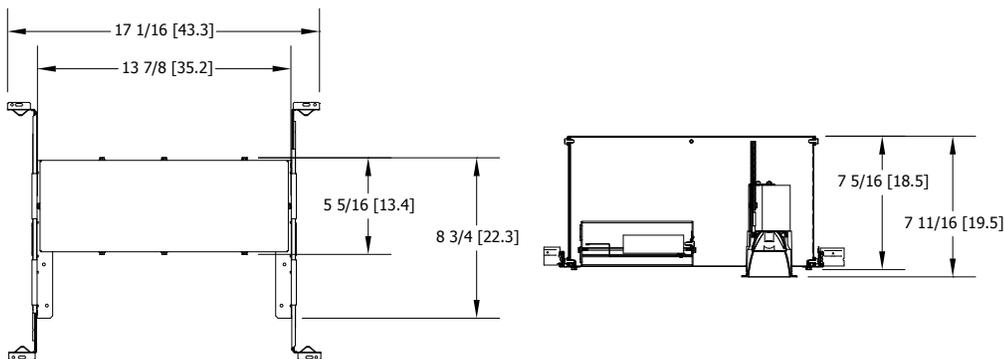
APERTURE: 2-1/4 (5.7)
CEILING OPENING: 2-5/8 (6.7)
OVERLAP TRIM: 3 (7.6)

1500 LUMEN OR HIGH AMBIENT OPTION STRUCTURAL REINFORCEMENT PAN



APERTURE: 2-1/4 (5.7)
CEILING OPENING: 2-5/8 (6.7)
OVERLAP TRIM: 3 (7.6)

IC / AIRTIGHT HOUSING CONSTRUCTION



1" Eco-Downlight

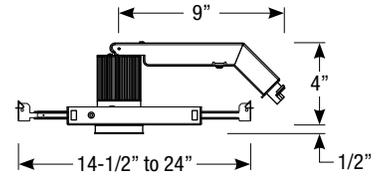
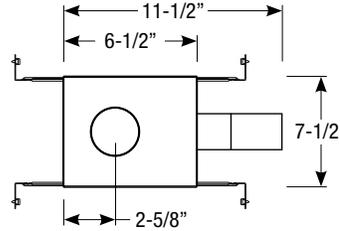
Non-IC New Construction Housing

Round or Square

Wattage	CCT	Delivered Lumens	Efficacy
8.5W	2700K	750lm	88lpw
8.5W	3000K	800lm	94lpw
13W	2700K	950lm	73lpw
13W	3000K	1050lm	81lpw
13W	3500K	1150lm	88lpw

Lumens will vary depending on optic, finish & trim type

Dimensions



Field Cuttable
 Ceiling Cut-out: 2-3/8" Ø

LED Light Engine

- 8.5W LED with 2700K or 3000K @ 90 CRI
- 13W LED with 2700K, 3000K or 3500K @ 90 CRI
- 2 SDCM binning
- 50,000 hours at 70% lumen maintenance (L70)

Field Replaceable Dimming Driver

- 8.5W Low power density (LPD) housings include an universal ELV / Triac driver with 120-277V input
- 13W housings are available with remote Lutron Hi-Lume® or universal 0-10V / ELV / Triac driver

Optics

50° flood optic included (10°, 30° and 80° optic are available, must specify)

Gasket for IC Air-Tight Installations

8.5W Low power density (LPD) housings can be converted to an IC Air-Tight housing with gasket, must specify EDLM-AT-GSKT.

Housing

- Galvanized-steel plaster frame must be kept 3" from insulation
- Cold rolled steel junction box with black anodized finish, (2) 1/2" trade size knockouts

Mounting

- Includes (2) galvanized steel adjustable bar hangers
- Adjust vertically to accommodates ceiling thickness from 1/2" to 3/4"
- Requires a minimum ceiling depth of 6-1/2"

Trim

- Available in round or square aluminum trim, consult factory for custom finishes
- Available in open reflector, baffle or shower trim
- Flush mount adapter available

Emergency

Remote inverter operates for 90 minutes with remote test switch available, requires above ceiling access.

Listing/Warranty

- Five (5) year limited warranty
- UL listed to US and Canadian standards for damp locations (wet location when used with shower trim)
- CEC (Title 24) Listed when used with reflector or baffle



Housing Order Matrix (Example: EDLM-NC-27-4)

Installation Type	CCT / CRI	Rev	Wattage / Driver
EDLM-NC (Non-IC)	<input type="radio"/> -27 (2700K / 90 CRI)	-4	<input type="radio"/> (blank) ³ (13W / ERP, Universal Dim, Triac/ELV/0-10V 10% 120-277V)
	<input type="radio"/> -30 (3000K / 90 CRI)		<input type="radio"/> -LR1 (13W / Remote Lutron Hi-lume® 2-Wire 1% 120V)
	<input type="radio"/> -35 ¹ (3500K / 90 CRI)		<input type="radio"/> -LPD ² (8.5W / ERP, Universal Dim, Triac/ELV 10% 120-277V)

1. Not available with 8.5W LPD driver

2. Available in 2700K and 3000K only

3. Forward and reverse phase dimming at 120V only

Optics

- EDLM-10-OPTIC-3 (10° Spot)
- EDLM-30-OPTIC-3 (30° Narrow Flood)
- EDLM-50-OPTIC-3 (50° Flood)
- EDLM-80-OPTIC-3 (80° Wide Flood)

Emergency

- EM-1000 (25W LED Remote Inverter)
- EM-1002 (10W LED Remote Emergency Driver)
- EM-1003 (35W LED Remote Inverter)
- EM-1004 (50W LED Remote Inverter)

Gasket for IC Air-Tight ceilings

- EDLM-AT-GSKT (Air-Tight IC Gasket for LPD housing only)

1" Eco-Downlight Open Reflector

Non-IC New Construction Housing

Round or Square

Catalog #: **TYPE L51**
 Project: AUERBACH·GLASOW
 Notes:

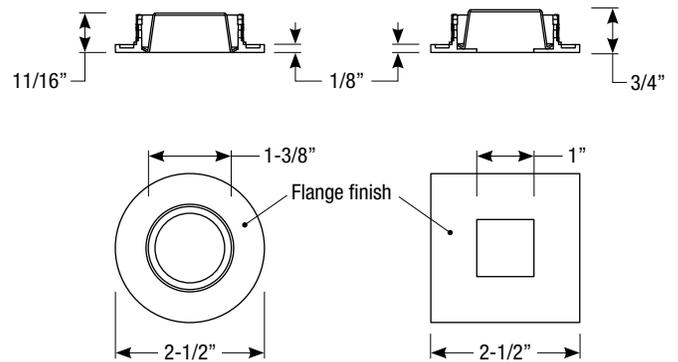
Open Reflector Trim Order Matrix (Example: EDLM-1002-3)

Series	Aperture / Finish	Rev
EDLM	○ -1001 (Round / Black Alzak Reflector / White Flange)	-3
	○ -1003 (Round / Black Alzak Reflector / Satin Aluminum Flange)	
	○ -1004 (Round / Haze Reflector / White Flange)	
	○ -1005 (Round / Haze Reflector / Satin Aluminum Flange)	
	○ -1006 (Round / White Reflector / White Flange)	
	○ -2001 (Square / Black Reflector / White Flange)	
	○ -2003 (Square / Black Reflector / Satin Aluminum Flange)	
	○ -2004 (Square / Haze Reflector / White Flange)	
	○ -2005 (Square / Haze Reflector / Satin Aluminum Flange)	
	○ -2006 (Square / White Reflector / White Flange)	

Flush Mount Adapter

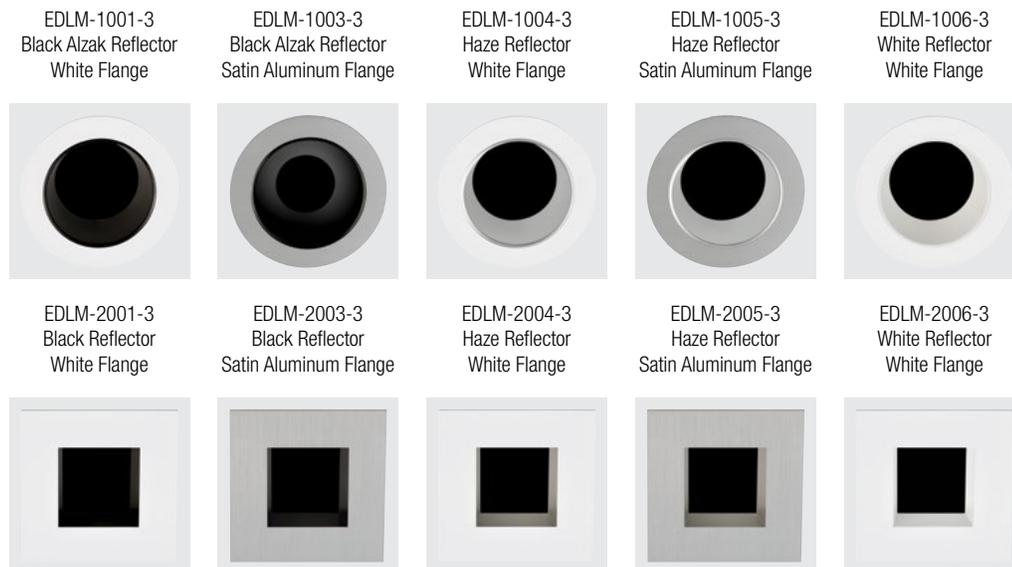
- EDLM-RD-FMA (Round Flush Mount Adapter)
- EDLM-SQ-FMA (Square Flush Mount Adapter)

Dimensions



Note: Open reflector does not allow adjustable mechanism to tilt

Trim Finishes



Revised 05/14/18

1" Eco-Downlight Baffle Downlight

Non-IC New Construction Housing

Round or Square

Catalog #: **TYPE L51**
 Project: AUERBACH · GLASOW
 Notes:

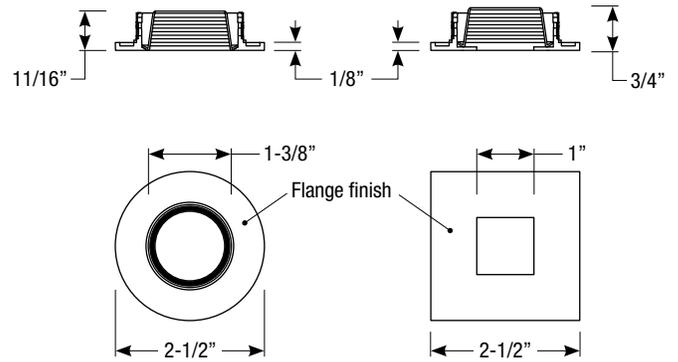
Baffle Downlight Trim Order Matrix (Example: EDLM-1102-3)

Series	Aperture / Finish	Rev
EDLM	○ -1100 (Round / White Baffle / White Flange)	-3
	○ -1101 (Round / Black Baffle / White Flange)	
	○ -1102 (Round / Black Baffle / Satin Aluminum Flange)	
	○ -2100 (Square / White Baffle / White Flange)	
	○ -2101 (Square / Black Baffle / White Flange)	
	○ -2102 (Square / Black Baffle / Satin Aluminum Flange)	

Flush Mount Adapter

- EDLM-RD-FMA (Round Flush Mount Adapter)
- EDLM-SQ-FMA (Square Flush Mount Adapter)

Dimensions



Note: Baffle downlight does not allow adjustable mechanism to tilt

Trim Finishes

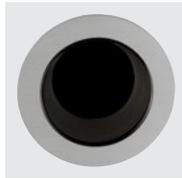
EDLM-1100-3
White Baffle
White Flange



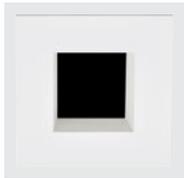
EDLM-1101-3
Black Baffle
White Flange



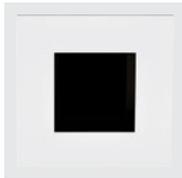
EDLM-1102-3
Black Baffle
Satin Aluminum Flange



EDLM-2100-3
White Baffle
White Flange



EDLM-2101-3
Black Baffle
White Flange



EDLM-2102-3
Black Baffle
Satin Aluminum Flange



1" Eco-Downlight Shower Trim

Non-IC New Construction Housing

Round or Square

Catalog #:

Type:

Project:

Date:

Notes:

Shower Trim Order Matrix (Example: EDLM-1200-3)

Series	Aperture / Finish	Rev
EDLM	○ -1200 (Round Shower Trim / White Flange)	-3
	○ -2200 (Square Shower Trim / White Flange)	

Flush Mount Adapter

- EDLM-RD-FMA (Round Flush Mount Adapter)
- EDLM-SQ-FMA (Square Flush Mount Adapter)

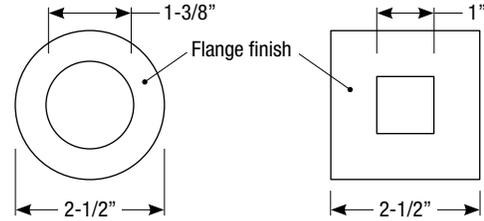
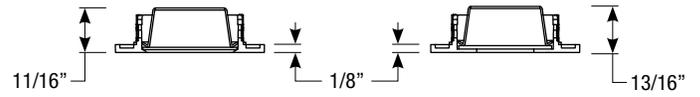
Trim Finishes

EDLM-1200-3
White Flange

EDLM-2200-3
White Flange



Dimensions



Note: Shower trim does not allow adjustable mechanism to tilt



Luminaire Type:
Catalog Number
(autopopulated):



Gotham Architectural Downlighting
LED Downlights

2" Incito®
Adjustable, Open

Solid-State Lighting
(US and International Patents Pending)



FEATURES

OPTICAL SYSTEM

- Superior 100% virgin silicone refractive optic enables maximum dimensional stability and optical transmission with no discoloration over life.
- Primary control of distribution occurs in refractive optic allowing for aesthetic versatility with trim color and finish.
- Eleven preset distribution patterns allow designers to achieve tailored effects.
- 2.5-Step MacAdam Ellipse.
- Self-flanged semi-specular or matte-diffuse lower reflector.
- Field interchangeable optics.

MECHANICAL SYSTEM

- Matte black enclosure ensures seamless integration into architecture.
- Post-installation vertical tilt and horizontal rotation adjustment possible from above or below ceiling.
- Accommodates 1/2" to 5/8" thick ceilings only.
- Full horizontal panning up to 365 degrees.
- 0-40° vertical tilt.
- Hot aiming below ceiling with indicator.
- Install from below architecture standard.
- Several additional mounting options available including a structural reinforcement pan, Chicago plenum, and Type IC.
- Standard ambient operating temperature: 25 °C. High ambient option available.

- Accommodates a wide range of applications including multiple plenum cross sections and ceiling thicknesses. Consult page 2.
- Light engine and driver are accessible from above or below ceiling.
- Flangeless trim option includes proprietary Gotham mud ring enabling seamless integration into drywall applications. Mud ring ships separately.

ELECTRICAL SYSTEM

- Solid-state LED light engine available in 2700 K, 3000 K, 3500 K or 4000 K color temperatures. Standard CRI: 80 typical. High CRI option available.
- Rated system life of >60,000 hours at 70% output.
- 120V TRIAC or ELV dimming and 0-10V dimming standard.
- Luminaire accepts parallel and branch circuit control wiring.

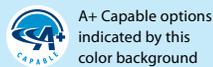
LISTINGS

- Fixtures are UL listed to meet US and Canadian standards; damp location listed.

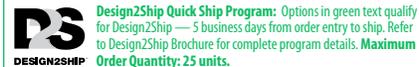
WARRANTY

- 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C.



A+ Capable options indicated by this color background



Design2Ship Quick Ship Program: Options in green text qualify for Design2Ship — 5 business days from order entry to ship. Refer to Design2Ship Brochure for complete program details. **Maximum Order Quantity: 25 units.**

Remotely located eldoLED DMX compatible dimming driver

EXAMPLE: **IC0 ADJ 35/10 2AR LSS 20D MVOLT UGZ**

Series	Color temperature	Nominal lumen values ¹	Aperture/Trim color	Trim Style	Finish	Beam
IC0 ADJ	27/ 2700 K	05 500 lumens	2AR Clear	(blank) Self-flanged	LSS Semi-specular	15D 15° beam angle
	30/ 3000 K	07 750 lumens	2PR Pewter			20D 20° beam angle
	35/ 3500 K	10 1000 lumens	2WTR Wheat	FL Flangeless	LD Matte diffuse	25D 25° beam angle
	40/ 4000 K	15² 1500 lumens	2GR Gold			30D 30° beam angle
			2WR³ White			35D 35° beam angle
			2BR³ Black			40D 40° beam angle
						45D 45° beam angle
						3515D Elliptical 35° x 15° beam angle
						5020D Elliptical 50° x 20° beam angle
						5060D Elliptical 50° x 60° beam angle
			6070D Elliptical 60° x 70° beam angle			

Voltage	Driver	Options
MVOLT⁴ 120 277	UGZ⁵ Universal dimming to 1% (0-10V, 120V TRIAC or ELV)	SF^{6,7} Single fuse TRW^{8,9} White painted flange TRBL^{9,10} Black painted flange CP² Chicago plenum NPP16D^{6,7,11} nLight® network power/relay pack with 0-10V dimming. NPP16DER^{6,7,11} nLight® network power/relay pack with 0-10V dimming. ER control fixtures on emergency circuit.
		CRI90 High CRI (90+) HAO² High ambient (40°C) ICAT² IC/Airtight housing construction NCH Structural reinforcement pan

ACCESSORIES order as separate catalog numbers (shipped separately)

OPTC^{2,12}	Additional optics available for field installation	HS258 2-5/8" Hole saw
OPTC2 KIT	Kit including a field interchangeable optic for each of the 13 preset beam distribution patterns	HS234FL 2-3/4" Hole saw for flangeless trim option AW50 Allen wrench (.050") for adjusting tilt

ORDERING INFORMATION

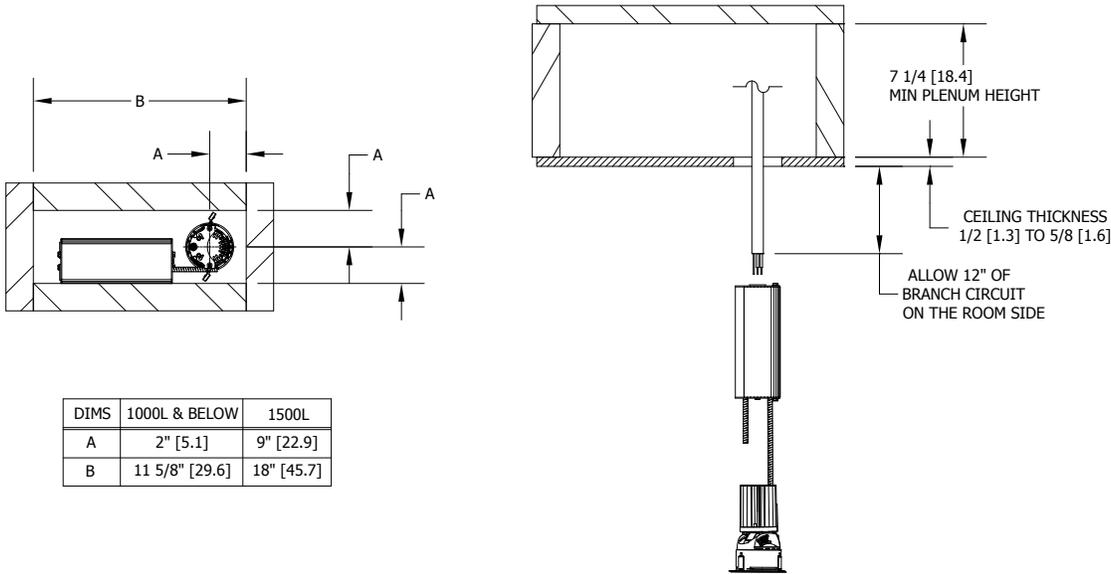


2" INCITO
Adjustable
Solid-State Lighting

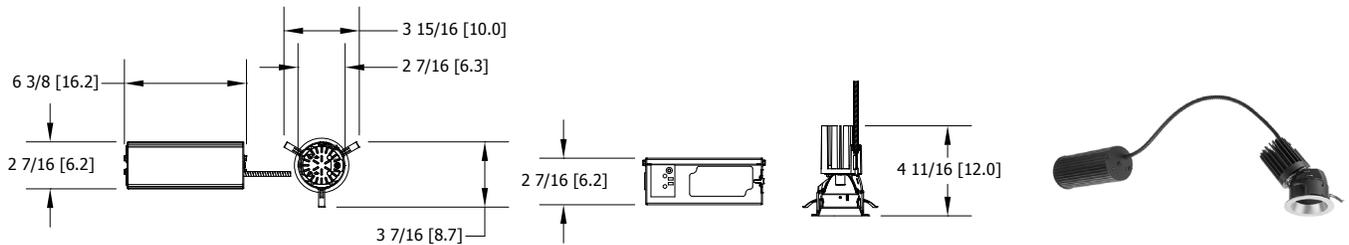
DIMENSIONAL DATA

All dimensions are inches (centimeters) unless otherwise noted.

RECESSED APPLICATION — MINIMUM CLEARANCE REQUIREMENTS



INSTALL-FROM-BELOW CONSTRUCTION, ALL LUMEN VALUES



APERTURE: 2-1/4 (5.7)
CEILING OPENING: 2-5/8 (6.7)
OVERLAP TRIM: 3 (7.6)

NOTES

ORDERING NOTES

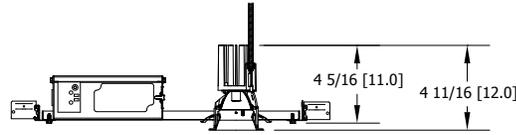
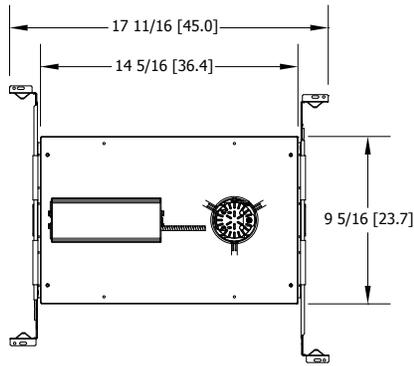
- Nominal lumen values at 0° tilt, 30° beam.
- 1500lm not available with CP, ICAT, or HAO.
- Not available with finishes.
- Multi-volt 120-277V.
- Refer to [TECH SHEET 240](#) for full list of recommended compatible dimmers. Control system electrical load, and protocol may limit minimum dim level.
- Device must be remote mounted. Will not be factory installed. Access required to location of remote mounted device.
- Must specify 120, 277, or 347V.
- Not specifiable with WR reflector.
- Not available with flangeless (FL) trim style.
- Not specifiable with BR reflector.
- Access to nPod necessary for servicing.
- Must specify desired optical distribution from available options in "Beam" column. i.e. OPTC2 15D or OPTC2 3515D. Includes additional capture rings.



DIMENSIONAL DATA

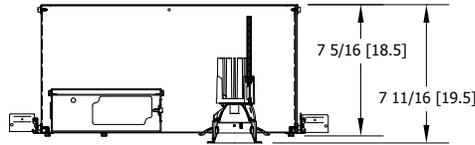
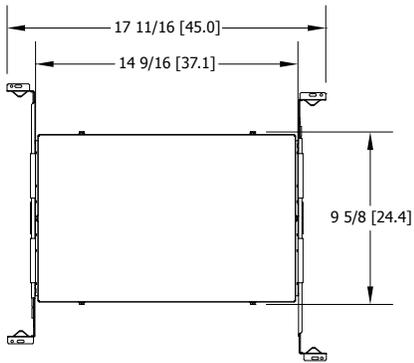
All dimensions are inches (centimeters) unless otherwise noted.

STRUCTURAL REINFORCEMENT PAN , ALL LUMEN VALUES



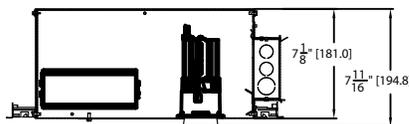
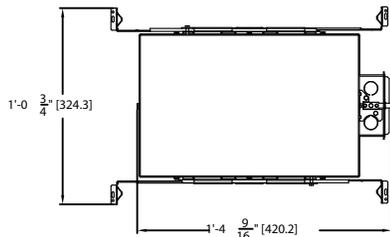
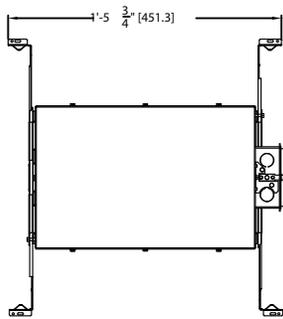
APERTURE: 2-1/4 (5.7)
CEILING OPENING: 2-5/8 (6.7)
OVERLAP TRIM: 3 (7.6)

IC / AIRTIGHT HOUSING CONSTRUCTION



APERTURE: 2-1/4 (5.7)
CEILING OPENING: 2-5/8 (6.7)
OVERLAP TRIM: 3 (7.6)

CHICAGO PLENUM CONSTRUCTION



DESCRIPTION

The Bridge™ LED recessed offers a traditional yet modern design with the latest in solid-state lighting technology. High performing WaveStream™ optics allow for maximum energy savings and optimal illumination in a ultra-minimalistic shallow recessed fixture. Two WaveStream optic options are available; a fully uniform pattern and a square pattern that provides a unique translucent appearance without sacrificing performance. Additional shielding options are also available including rectangular perf, round perf, and nano-prism inlays. Available in 2x2, 2x4, 1x4 sizes along with several popular metric sizes, the Bridge is highly configurable with well-thought-out options and a number of architectural styles for application versatility.

SPECIFICATION FEATURES

Construction

Shallow 3-7/8" deep housing is a 22 gauge steel reflector with injection molded high-reflectance polycarbonate end plates securely attached with integral snaps and screws for strength, rigidity and the elimination of gaps. WaveStream light engine with extruded aluminum heatsinks span across the bottom of the luminaire. Drivers can be accessed via plenum. Large access plate for supply connection. Fixture weight: 20.0 lbs.

Optics

Optical grade acrylic embedded with patented WaveStream Accu-Aim™ optics for optimal distribution, excellent uniformity, and high performance. Center light engine becomes virtually clear in the off-state.

Shielding

Perf pattern and nano-prismatic inlays are available as additional aesthetic options. Perf inlay available in round or rectangular pattern. Nano-prism inlay is a high light transmission material offering additional brightness mitigation.

Finish

Fixture housing and back reflector are high reflectance white using electrostatically applied polyester powder coat paint for durability and luminous uniformity.

Electrical

Long-life LED system coupled with electrical driver to deliver optimal performance. Projected life is 100,000 at 75% lumen output. LEDs are available in 3000K, 3500K or 4000K with a typical CRI ≥ 85.

Standard drivers are 0-10 volt continuous dimming that work with any 0-10V control/dimmer. Or, specify Digital Addressable Lighting Interface (DALI) drivers; for use with Fifth Light controls. See ordering information for details.

Mounting

Universal flange design works with most lay-in ceiling types. Integral pry-out tabs secure luminaire to ceiling grid from above. Fixture offers tie-in locations for tie-wire on all corners. Consult local code for appropriate tie-wire recommendations. See Technical Notes section for drywall frame kit and surface mount kit options.

Compliance

Components are UL recognized and luminaires are cULus listed for 25°C ambient environments, damp location listed, and RoHS compliant. DesignLights Consortium™ Qualified and classified for DLC Standard, refer to www.designlights.org for details.

Warranty

Five-year warranty.



BRIDGE - BRG

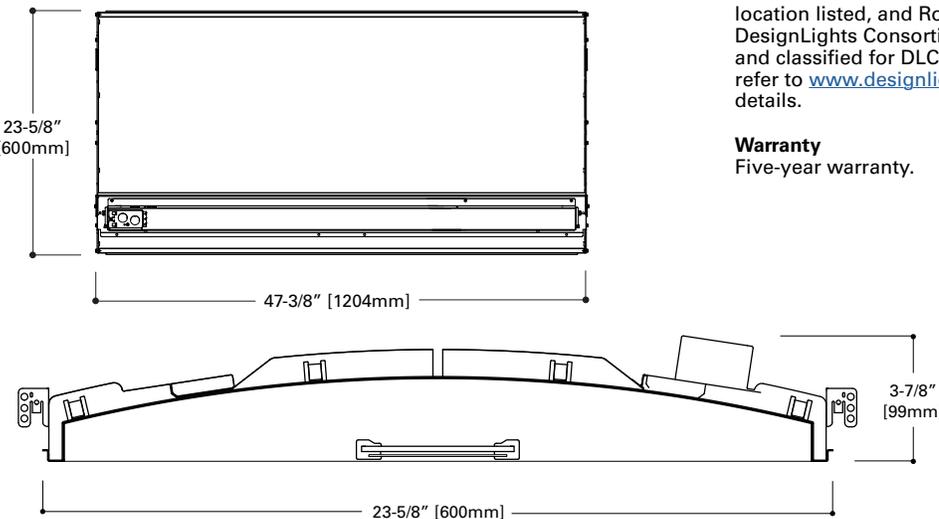
Fully Uniform

WaveStream™ LED

2' x 4' Recessed
3-7/8" Depth

CERTIFICATION DATA
cULus - 1598
Damp Location Listed
IC Rated
LM79/LM80 Compliant
ROHS Compliant
DesignLights Consortium™ Qualified

LumaWatt Pro
Wireless sensing & control system | **enlighted**



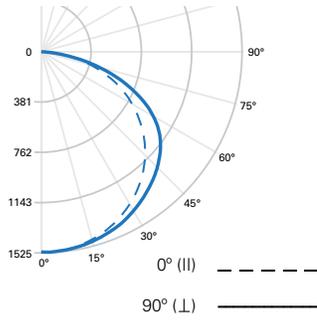
ORDERING INFORMATION

Sample Number: BRG-WS-3L35-LD2-UNV-24-T1-STD-SWPD1-EL14W-AR

Series ⁽¹⁾	Optics/Shielding	Light Level (2x4 Nominal delivered lumens)	Color Temperature	LED Version	Input Voltage
BRG = Bridge Recessed	WS = WaveStream Fully Uniform WD = WaveStream with Round Perf Inlay WG = WaveStream with Rectangular Perf Inlay WN = WaveStream with Nano-Prism Perf Inlay	1 = Light Level 1 (3000 Lms, 27W) 2 = Light Level 2 (4000 Lms, 39W) 3 = Light Level 3 (5000 Lms, 47W) 4 = Light Level 4 (6000 Lms, 58W) 5 = Light Level 5 (7000 Lms, 70W)	L30 = LED 3000K L35 = LED 3500K L40 = LED 4000K	LD2 = LED 2.0	UNV = Universal (120V-277V) 347 = 347V ^{(2) (9)}
Size	Ceiling Type	Driver Type	Integral Sensor (Optional)	Emergency (Optional)	Options
24 = 2' x 4'	T1 = 1" T-Bar, Slot Grid, and 9/16" Tegular ⁽³⁾ T9 = 9/16" T-Bar (Flush)	STD = Standard 0-10V (10%-100%) HCD = 0-10V (1%-100%) ⁽⁶⁾ STP = Step Dimming (Bi-Level, 40%) ^{(5) (7)} 5LT = Fifth Light DALI (10%-100%) ⁽⁴⁾ 5LTHD = Fifth Light DALI (1%-100%) ^{(4) (8)} SR = Sensor Ready (5%-100%)	SVPD1 = Integrated Occupancy/Daylight Sensor for Local Control ⁽¹⁰⁾ SWPD1 = WaveLinX Wireless Integral Sensor ⁽¹¹⁾ LWIPD1 = Lumawatt Pro Wireless Integral Sensor ⁽¹²⁾	EL14W = 14-watt 120V-277V Integral EM Battery Pack ⁽¹³⁾ GTD2 = Bodine Generator Transfer Device ⁽¹⁴⁾	AR = Air Return CP = Chicago Plenum ⁽¹⁵⁾ W6 = 6' Whip Flex W12 = 12' Whip Flex

See page 3 for technical notes

PHOTOMETRICS



FILE NAME: BRG-WS-3L35-LD2-UNV-24-STD.IES

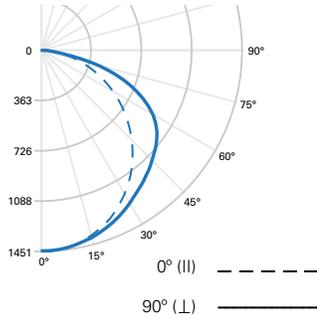
LAMP: (LD2) LED 3500K
LUMENS: 5175 Lm
WATTS: 47.2 W
EFFICACY: 110 Lm/W
TEST NO.: P189656
SC: (II) 1.31, (L) 1.37

ZONAL LUMENS SUMMARY

Zone	Lumens	% Fixture
0°-30°	1215	23.5
0°-40°	2035	39.3
0°-60°	3835	74.1
0°-90°	5175	100

LUMINANCE DATA (cd/m²)

Vertical Angle	0°	45°	90°
45°	2415	2528	2698
55°	2435	2663	2932
65°	2434	2775	3024
75°	2315	2742	2713
85°	1682	1594	1446



FILE NAME: BRG-WG-3L35-LD2-UNV-24-STD.IES

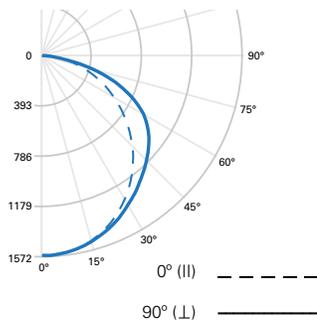
LAMP: (LD2) LED 3500K
LUMENS: 4669 Lm
WATTS: 47.2 W
EFFICACY: 99 Lm/W
TEST NO.: P189671
SC: (II) 1.24, (L) 1.32

ZONAL LUMENS SUMMARY

Zone	Lumens	% Fixture
0°-30°	1129	24.2
0°-40°	1863	39.9
0°-60°	3446	73.8
0°-90°	4669	100

LUMINANCE DATA (cd/m²)

Vertical Angle	0°	45°	90°
45°	2015	2230	2452
55°	1915	2368	2731
65°	1789	2599	2921
75°	1630	2703	2604
85°	1387	1446	1299



FILE NAME: BRG-WN-3L35-LD2-UNV-24-STD.IES

LAMP: (LD2) LED 3500K
LUMENS: 4829 Lm
WATTS: 47.2 W
EFFICACY: 102 Lm/W
TEST NO.: P189701
SC: (II) 1.29, (L) 1.29

ZONAL LUMENS SUMMARY

Zone	Lumens	% Fixture
0°-30°	1214	25.1
0°-40°	1994	41.3
0°-60°	3629	75.1
0°-90°	4829	100

LUMINANCE DATA (cd/m²)

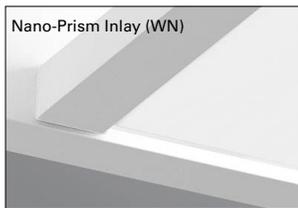
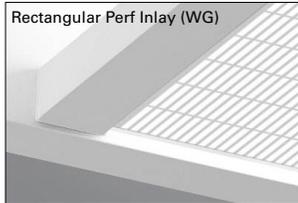
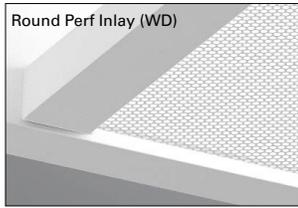
Vertical Angle	0°	45°	90°
45°	2168	2324	2510
55°	2049	2408	2708
65°	1929	2556	2824
75°	1739	2554	2425
85°	1476	1416	1209

Note: Round Perf (WD) photometric performance is similar to Rectangular Perf (WG). Reference IES-format photometry online for more detail.

LUMEN MAINTENANCE

Ambient Temperature	TM-21 Lumen Maintenance (100,000 hours)	Theoretical L70 (Hours)
25°C	>75%	125,000

INLAY OPTIONS



ENERGY AND PERFORMANCE DATA

2x4 - Bridge Light Level Outputs and Distributions (3500K)				
Series	Light Level	Delivered Lumens	Wattage	Efficacy (LPW)
BRG-WS	1	3145	27.1	116
	2	4148	38.5	108
	3	5175	47.2	110
	4	6160	58.5	105
	5	7164	70.2	102
BRG-WD	1	2840	27.1	105
	2	3746	38.5	97
	3	4670	47.2	99
	4	5559	58.5	95
	5	6469	70.2	92
BRG-WG	1	2838	27.1	105
	2	3743	38.5	97
	3	4669	47.2	99
	4	5559	58.5	95
	5	6465	70.2	92
BRG-WN	1	2935	27.1	108
	2	3871	38.5	100
	3	4829	47.2	102
	4	5749	58.5	98
	5	6686	70.2	95

Stock	Catalog Number	Product Description	Delivered Lumens	Wattage	Efficacy (LPW)
Stock	BRG-WS-40L35-LD2-UNV-24-T1-STD	2x4 Bridge, 4000 lm (LL2), 3500K, 0-10V	4148	38.5	108
	BRG-WS-40L40-LD2-UNV-24-T1-STD	2x4 Bridge, 4000 lm (LL2), 4000K, 0-10V	4235	38.5	110
	BRG-WS-50L35-LD2-UNV-24-T1-STD	2x4 Bridge, 5000 lm (LL3), 3500K, 0-10V	5175	47.2	110
	BRG-WS-50L40-LD2-UNV-24-T1-STD	2x4 Bridge, 5000 lm (LL3), 4000K, 0-10V	5283	47.2	112

TECHNICAL NOTES

- Dimming wires come standard in all LED fixtures but can be capped in the field for standard switched operation.
- Integral 347V electronic driver with STD 0-10V option only. Factory supplied remote transformer for all other driver/dimming options.
- "T1" ceiling type is compatible with Metalux DF Series Drywall Frame Kits and Metalux Universal Surface Mount Kits, ordered separately from Metalux. For 2x2 drywall frame kit, order part **#DF-24-W**. For 2x2 surface mount kit, order part **#SK-24-WS**. Refer to the surface mount kit specification sheet for more information.
- Must be used in conjunction with a DALI control system. For a complete listing of Fifth Light Technology products and other solutions from Cooper Controls, visit www.eaton.com/lightingsystems.
- 2x4: STP driver not available in Light Levels 1.
- 2x4: Two HCD drivers required for Light Levels 4 and 5.
- 2x4: Two STP drivers required for Light Level 5.
- 2x4: Two 5LTHD drivers required for Light Levels 4 and 5.
- 2x4: Two 347V 0-10V drivers required for Light Level 5.
- SV sensor works only with 0-10V drivers and is factory prewired to the driver for stand-alone control. Order **#SHH-01** for Programming Remote and **#ISHH-02** for Personal Control Remote.
- SW sensor works only with STD and HCD 0-10V drivers. Designed for use with the WaveLinX Wireless Connected Lighting system. For complete WaveLinX wireless solutions, visit www.eaton.com/wavelinx.
- LWI sensor requires the use of the SR driver. Must be used in conjunction with a LumaWatt Pro control system. For complete LumaWatt Pro wireless solutions, visit www.eaton.com/lumawattpro.
- Integral emergency battery pack is 14W maximum, 90 minute output. A test switch/indicator button can be tested safely from the ground using a laser pointer, while the patented EZ Key prevents accidental discharge of the battery during construction. For approximate delivered lumens multiply the lumens per watt of the desired fixture by the wattage of the emergency battery pack (100 lm/W x 14=1400 lumens). Emergency battery pack not available with two driver configurations.
- Used to transfer fixture to secondary power source for life-safety operation. When used with a dimming fixture, two devices are required to ensure control is disabled while operating under emergency power. Product height with transfer device is 5" (126mm).
- Chicago plenum not available with GTD.

SVPD1 INTEGRATED SENSOR

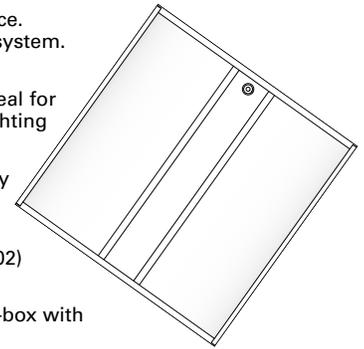
The Bridge with Integrated Sensor technology provides automatic energy savings without sacrificing performance. Traditionally, these types of energy savings required coordination between the luminaire and a lighting control system. The Bridge delivers superior lighting with integrated PIR occupancy and daylighting controls.

Capture the benefits of traditional lighting controls, without complicated coverage planning or special wiring. Ideal for new construction or retrofit, the Bridge delivers automatic ON to an energy saving light level, while ensuring lighting is turned OFF when the space is unoccupied.

The integral daylight sensor reduces the need for special daylight zone planning. The luminaire will automatically adjust the light level based on reflected light beneath the sensor in a closed loop method.

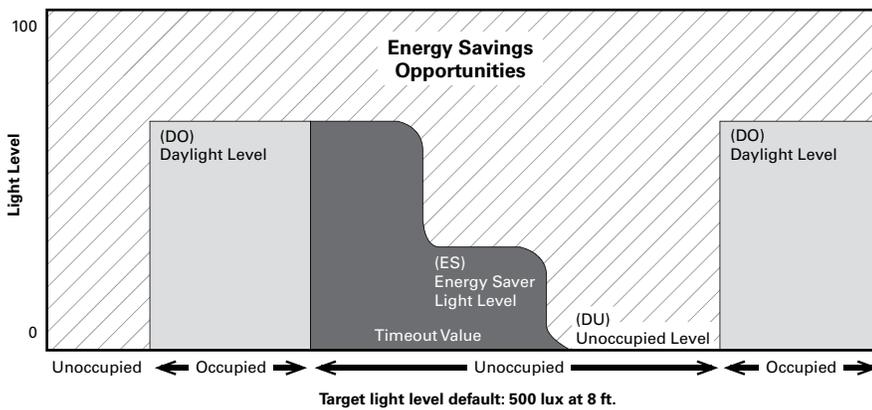
Occupied daylight light levels and unoccupied light levels can be adjusted using the integrated sensor programming remote (Catalog Number: ISHH-01). The integrated sensor personal remote (Catalog Number: ISHH-02) provides code compliant manual raise, lower, ON, OFF control.

The Bridge with Integrated Sensor is easy to install with no special wiring and ensures energy savings out-of-the-box with default control settings.

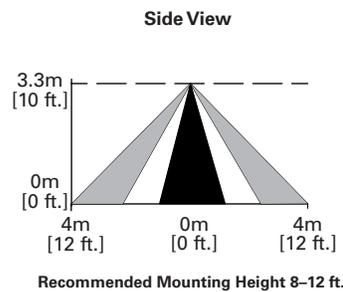
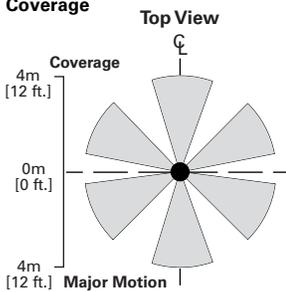


How it works:

- As the user enters the space controlled by the integral sensor, the lighting turns ON to the daylight level (default 500 lux).
- Lighting will remain at the daylight level until the space is unoccupied. This will start the occupancy timeout period (default 20 minutes).
- If the space remains unoccupied for half of the timeout period, the lighting will automatically reduce to the Energy Saver light level. This adjustable light level is typically half of the occupied daylight level.
- At the end of the timeout period the lighting will go to the unoccupied light level. This adjustable light level uses the OFF default setting.



Coverage



Optional Remote Controls

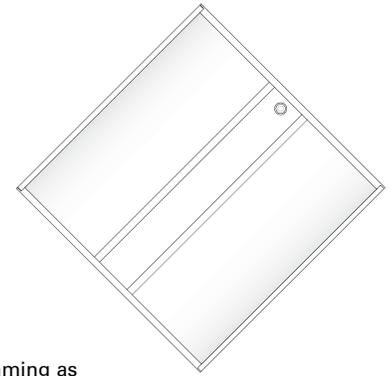


ISHH-01 Programming Remote



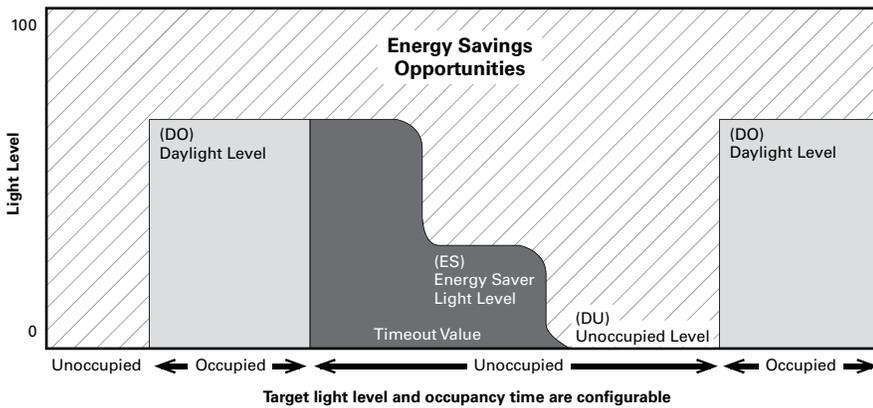
ISHH-02 Personal Control Remote

LumaWatt Pro with Enlighted is an integrated system of luminaires, digital sensors, and application-based software for any size project. The strengths of LumaWatt Pro with Enlighted are based on the independent, secure operation of individual sensors in every lighting fixture, combined with wireless communication to the powerful Energy Manager. The system aggregates input from the project to provide visibility to entire aspects of environmental data from the project, putting the input into easy-to-read dashboards of analytic detail. The dashboards enable you to take additional action with the system to improve energy savings, master the use of the space, interact with heating, ventilation, and air-conditioning (HVAC) systems, and report on system modes to reduce maintenance. By collecting granular, real-time data from our state-of-the-art integrated sensors to provide advanced, smart building solutions, you are in control.



How it works:

- Luminaires are factory wired to sensors, which provide control based on digital occupancy and daylight dimming as independent, fault-proof, resilient networks of powerful end-points.
- Sensors communicate to each other, and gateways using easy wireless installation with secure set up.
- Gateways communicate using industry-standard wired technology to the Energy Manager, for powerful, familiar dashboards of useful information tailored for easy use on a connected computer.
- Energy Managers connect to cloud-based applications, maximizing the dense, data-rich sensing within the footprint of the luminaire for management of the building environment.



Energy Manager Software



Energy Dashboard

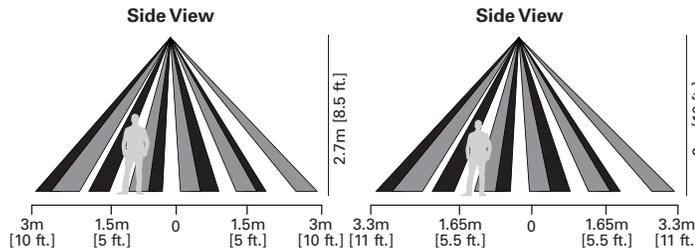


Space Analysis Application

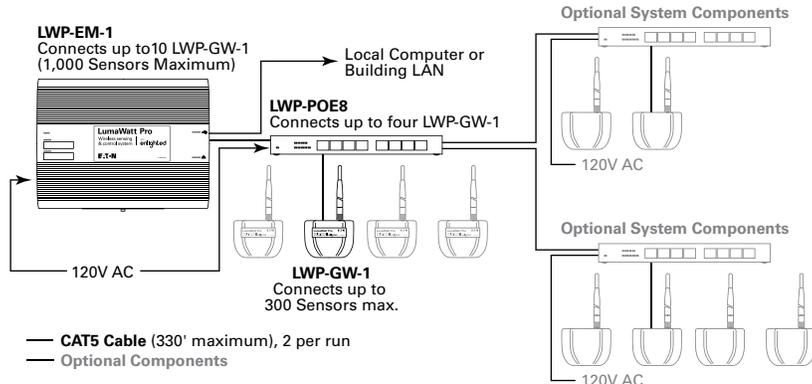


AIRE Integration Application

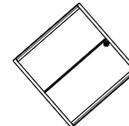
Coverage, LWI Option



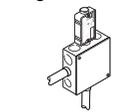
System Configurations



Indoor Fixture



Example No.: DRI-WS-3L35-UNV-22-T1-SR-LWI



Example No.: LWP-PC-01-20



Example No.: LWP-WS-2-00



Outdoor Fixture

Example No.: GLEON-AE-04-LED-E1-T3-GM-LWR-LN

PHILIPS
Day-Brite
CFI

Recessed

T-Grid LED
troffer 2x4

3200, 3800, 4300, 4800,
5400, or 7400 lumens



Project: _____
Location: _____
Cat.No: _____
Type: _____
Lumens: _____ Qty: _____
Notes: _____

The Philips Day-Brite / Philips CFI T-Grid LED troffer is an energy efficient low profile luminaire offering excellent performance for general lighting applications such as offices, schools, healthcare, or retail. Featuring a frosted prismatic lens to enhance visual comfort, the T-Grid LED Troffer utilizes highly reliable and efficient Philips LED platform boards and dimmable driver, enabling market leading efficiency in its category.

Ordering guide

Example: 2TG32L840-4-FS-02F-UNV-DIM

Width	Family	Ceiling Type	Lumen Package	Color	Length	Door Frame	Lens	Voltage	Driver	Options
2	T	G		-	4	-	-	-	-	
2 2'	T T-Grid LED troffer	G Grid	32L 3200 nominal delivered lumens 38L 3800 nominal delivered lumens 43L 4300 nominal delivered lumens 48L 4800 nominal delivered lumens 54L 5400 nominal delivered lumens 74L 7400 nominal delivered lumens	830 80 CRI, 3000K 835 80 CRI, 3500K 840 80 CRI, 4000K 850 80 CRI, 5000K	4 4'	FS Flat Steel FA Flat Aluminum RA Regressed Aluminum	02F Pattern 12, .100" nominal diffuse 50% 12F DB 12 .125" nominal diffuse 50% 19F DB 19 .156" nominal diffuse 50%	UNV Universal Voltage 120-277V 347 347V	DIM 0-10V dimming SDIM Step dimming to 40% input power	F1 3/8" flex, 3 wire, 18 gauge 6' F2 3/8" flex, 4 wire, 18 gauge 6' F1/D 3/8" twin flex, 3 wire, 18 gauge 6', for dimmable luminaires F2/SW 3/8" single flex, 5 wire, 18 gauge 6', for dimmable luminaires EMLED ^{2,3} Integral emergency battery pack 1W 1-way gasket between lens & door frame (not avail. for RA door frame) 2W 1-way & gasket between door frame & housing 3W 2-way & gasket between housing & ceiling (field installed) GLR Fusing, fast blow CHIC Chicago Plenum rated DSC Quick driver disconnect

Footnotes

- 1 SDIM not available with 74L lumen option
- 2 Not available for 74L-347V
- 3 1100 nominal lumens delivered in DC mode

Accessories (order separately)

- **FMA24** – 2'x4' "F" mounting frame for NEMA "F" mounting
- **FKTG824** – Flange conversion kit, 2'x4'



2TG T-Grid LED troffer 2x4

3200, 3800, 4300, 4800, 5400, or 7400 lumens

Application

- High efficacy long life solid state lighting platform.
- General lighting distribution is excellent for ambient lighting.
- High CRI source provides excellent color rendering.
- LEDs are an excellent source for use with controls since frequent switching does not affect the life of the light source.

Construction/finish

- A quality low-profile troffer with specification features for NEMA "G" grid, NEMA "NFG" narrow face grid, NEMA "GR" grid regressed, or NEMA "F" flange ceiling types.
- 3" nominal housing depth, 3-3/16" maximum depth.
- Smooth rolled edges on all four sides for easy handling.
- Die-formed one piece housing includes stiffening embosses and provides increased rigidity.
- Housing is multi-stage phosphate treated for maximum corrosion resistance and finish coat is high reflectance baked white enamel.
- Integral baffling system to prevent light leaks.

- 2 sets of integral grid clips (wraparound and fold-out) for maximum mounting flexibility.
- Integral wire hanger holes for independent wire suspension.
- Embosses with holes provided in housing end for screwing to T-bar if desired.
- 7/8" K.O.'s provided in each end cap for through wiring.
- Factory installed access plate in housing top includes 7/8" hole with rolled edge and 7/8" K.O.
- Carton includes integral carrying handle for easy handling.

Electrical

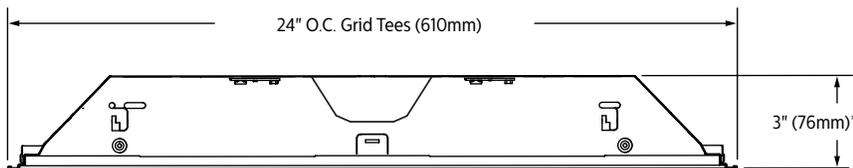
- Standard 0-10V dimming.
- Driver and LED boards are accessible from below. LED boards are individually replaceable if required.
- Five-year luminaire limited warranty including LED boards and driver. Visit www.philips.com/warranties for complete warranty information.
- High efficiency LEDs have 50,000 hour rated life (defined by testing at 70% lumen maintenance (L70)), based on 25°C ambient operating temperature.

- cETLus listed to UL and CSA standards, suitable for damp location.
- T-Grid LED luminaires are DesignLights Consortium® qualified. Please see the DLC QPL list for exact catalog numbers (<http://www.designlights.org/QPL>).
- Many luminaire components, such as reflectors, refractors, lenses, sockets, lampholders, and LEDs are made from various types of plastics which can be adversely affected by airborne contaminants. If sulfur based chemicals, petroleum based products, cleaning solutions, or other contaminants are expected in the intended area of use, consult factory for compatibility.

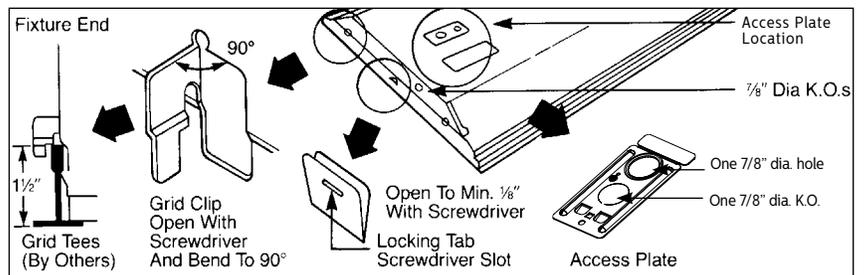
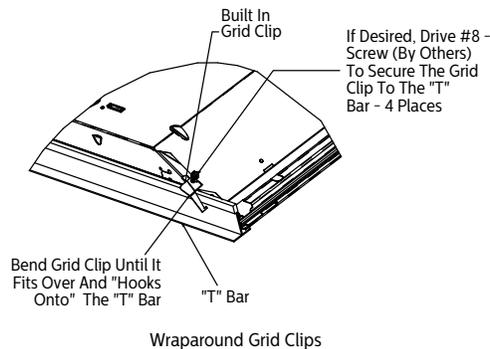
Enclosure

- Full "C" channel door frames for improved lens support and reduced shipping damage.
- Flat steel door frame features smooth rolled edges inside and outside.
- All door frames have mitered corners.
- All door frames use T-hinges and can be hinged and latched from either side.
- Opposable spring loaded latches are standard for easy operation and consistent retention.

Dimensions



*EMLED option adds 1-3/4" to overall height



Fold-Out Grid Clips

2TG T-Grid LED troffer 2x4

3200, 3800, 4300, 4800, 5400, or 7400 lumens

Photometry

2x4 T-Grid LED troffer, 3200 nominal delivered lumens

LER – 112

Catalog No. 2TG32L840-4-FS-02F-UNV Test No. 33527 S/MH 1.2 Lamp Type LED Lumens 3071 Input Watts 27.4 Comparative yearly lighting energy cost per 1000 lumens – \$2.14 based on 3000 hrs. and \$.08 pwr KWH. The photometric results were obtained in the Philips Day-Brite laboratory which is NVLAP accredited by the National Institute of Standards and Technology. Photometric values based on test performed in compliance with LM-79.	Candlepower				Light Distribution			Average Luminance					
	Angle	End	45	Cross	Degrees	Lumens	% Luminaire	Angle	End	45°	Cross		
	0	1293	1293	1293	0-30	993	32.3	45	1646	1537	1415		
	5	1291	1287	1284	0-40	1588	51.7	55	1361	1206	1082		
	15	1246	1240	1224	0-60	2564	83.5	65	1087	911	874		
	25	1143	1123	1095	0-90	3070	100.0	75	962	815	848		
	35	973	938	892				85	1103	828	655		
	45	746	697	641	Coefficients of Utilization								
	55	500	443	398	EFFECTIVE FLOOR CAVITY REFLECTANCE 20 PER (pfc=0.20)								
	65	294	247	237	pcc	80			70			50	
75	160	135	141	pw	70	50	30	70	50	30	50	30	
85	62	46	37	RRCR									
				0	118	118	118	115	115	115	111	111	
				1	109	105	101	107	103	98	97	94	
				2	100	92	85	97	91	84	86	81	
				3	92	81	73	90	80	72	78	70	
				4	84	72	65	81	71	64	69	63	
				5	78	66	56	76	65	56	63	56	
				6	72	59	51	70	58	51	56	50	
				7	67	54	46	66	54	46	52	45	
				8	63	50	41	60	48	40	47	40	
				9	58	46	38	57	45	38	44	36	
				10	55	42	34	54	41	34	40	34	

2x4 T-Grid LED troffer, 3800 nominal delivered lumens

LER – 111

Catalog No. 2TG38L840-4-FS-02F-UNV Test No. 33528 S/MH 1.2 Lamp Type LED Lumens 3660 Input Watts 33 Comparative yearly lighting energy cost per 1000 lumens – \$2.16 based on 3000 hrs. and \$.08 pwr KWH. The photometric results were obtained in the Philips Day-Brite laboratory which is NVLAP accredited by the National Institute of Standards and Technology. Photometric values based on test performed in compliance with LM-79.	Candlepower				Light Distribution			Average Luminance					
	Angle	End	45	Cross	Degrees	Lumens	% Luminaire	Angle	End	45°	Cross		
	0	1542	1542	1542	0-30	1184	32.4	45	1917	1892	1868		
	5	1535	1537	1538	0-40	1894	51.8	55	1581	1519	1499		
	15	1477	1481	1481	0-60	3055	83.5	65	1267	1182	1214		
	25	1349	1352	1348	0-90	3657	100.0	75	1132	1067	1189		
	35	1142	1139	1131				85	1233	1214	1407		
	45	868	857	846	Coefficients of Utilization								
	55	581	558	551	EFFECTIVE FLOOR CAVITY REFLECTANCE 20 PER (pfc=0.20)								
	65	343	320	329	pcc	80			70			50	
75	188	177	197	pw	70	50	30	70	50	30	50	30	
85	69	68	79	RRCR									
				0	118	118	118	115	115	115	111	111	
				1	109	105	101	107	103	98	97	94	
				2	100	92	85	97	91	84	86	81	
				3	92	81	73	90	80	72	78	70	
				4	84	72	65	81	71	64	69	63	
				5	78	66	56	76	65	56	63	56	
				6	72	59	51	70	58	51	56	50	
				7	67	54	46	66	54	46	52	45	
				8	63	50	41	60	48	40	47	40	
				9	58	46	38	57	45	38	44	36	
				10	55	42	34	54	41	34	40	34	

2TG T-Grid LED troffer 2x4

3200, 3800, 4300, 4800, 5400, or 7400 lumens

Photometry

2x4 T-Grid LED troffer, 4300 nominal delivered lumens

LER – 109

Catalog No. 2TG43L840-4-FS-02F-UNV Test No. 33530 S/MH 1.2 Lamp Type LED Lumens 4189 Input Watts 38.4 Comparative yearly lighting energy cost per 1000 lumens – \$2.20 based on 3000 hrs. and \$.08 pwr KWH. The photometric results were obtained in the Philips Day-Brite laboratory which is NVLAP accredited by the National Institute of Standards and Technology. Photometric values based on test performed in compliance with LM-79.	Candlepower				Light Distribution			Average Luminance			
	Angle	End	45	Cross	Degrees	Lumens	% Luminaire	Angle	End	45°	Cross
	0	1764	1764	1764	0-30	1354	32.3	45	2191	2163	2136
	5	1756	1757	1759	0-40	2166	51.7	55	1805	1735	1714
	15	1690	1694	1694	0-60	3495	83.5	65	1449	1347	1389
	25	1544	1546	1542	0-90	4188	100.0	75	1293	1219	1362
	35	1304	1302	1294							
	45	992	980	968							
	55	663	637	630							
	65	392	365	376							
75	214	202	226								
85	79	77	90								
Coefficients of Utilization EFFECTIVE FLOOR CAVITY REFLECTANCE 20 PER (pfc=0.20)											
pcc		80			70			50			
pw		70	50	30	70	50	30	50	30		
RCR											
0	118	118	118	115	115	115	111	111			
1	109	105	101	107	103	98	97	94			
2	100	92	85	97	91	84	86	81			
3	92	81	73	90	80	72	78	70			
4	84	72	65	81	71	64	69	63			
5	78	66	56	76	65	56	63	56			
6	72	59	51	70	58	51	56	50			
7	67	54	46	66	54	46	52	45			
8	63	50	41	60	48	40	47	40			
9	58	46	38	57	45	38	44	36			
10	55	42	34	54	41	34	40	34			

2x4 T-Grid LED troffer, 4800 nominal delivered lumens

LER – 107

Catalog No. 2TG48L840-4-FS-02F-UNV Test No. 33531 S/MH 1.2 Lamp Type LED Lumens 4633 Input Watts 43.2 Comparative yearly lighting energy cost per 1000 lumens – \$2.24 based on 3000 hrs. and \$.08 pwr KWH. The photometric results were obtained in the Philips Day-Brite laboratory which is NVLAP accredited by the National Institute of Standards and Technology. Photometric values based on test performed in compliance with LM-79.	Candlepower				Light Distribution			Average Luminance			
	Angle	End	45	Cross	Degrees	Lumens	% Luminaire	Angle	End	45°	Cross
	0	1950	1950	1950	0-30	1498	32.3	45	2423	2392	2366
	5	1942	1943	1945	0-40	2395	51.7	55	1997	1919	1899
	15	1868	1872	1874	0-60	3866	83.5	65	1602	1492	1538
	25	1707	1709	1705	0-90	4632	100.0	75	1433	1353	1506
	35	1443	1440	1430							
	45	1098	1084	1072							
	55	734	705	698							
	65	434	404	417							
75	238	224	250								
85	88	86	101								
Coefficients of Utilization EFFECTIVE FLOOR CAVITY REFLECTANCE 20 PER (pfc=0.20)											
pcc		80			70			50			
pw		70	50	30	70	50	30	50	30		
RCR											
0	118	118	118	115	115	115	111	111			
1	109	105	101	107	103	98	97	94			
2	100	92	85	97	91	84	86	81			
3	92	81	73	90	80	72	78	70			
4	84	72	65	81	71	64	69	63			
5	78	66	56	76	65	56	63	56			
6	72	59	51	70	58	51	56	50			
7	67	54	46	66	54	46	52	45			
8	63	50	41	60	48	40	47	40			
9	58	46	38	57	45	38	44	36			
10	55	42	34	54	41	34	40	34			

2TG T-Grid LED troffer 2x4

3200, 3800, 4300, 4800, 5400, or 7400 lumens

Photometry

2x4 T-Grid LED troffer, 5400 nominal delivered lumens

LER – 105

Catalog No. 2TG54L840-4-FS-02F-UNV Test No. 33532 S/MH 1.2 Lamp Type LED Lumens 5179 Input Watts 49.3 Comparative yearly lighting energy cost per 1000 lumens – \$2.29 based on 3000 hrs. and \$.08 pwr KWH. The photometric results were obtained in the Philips Day-Brite laboratory which is NVLAP accredited by the National Institute of Standards and Technology. Photometric values based on test performed in compliance with LM-79.	Candlepower				Light Distribution			Average Luminance			
	Angle	End	45	Cross	Degrees	Lumens	% Luminaire	Angle	End	45°	Cross
	0	2180	2180	2180	0-30	1674	32.3	45	2709	2677	2643
	5	2171	2172	2174	0-40	2677	51.7	55	2232	2151	2123
	15	2088	2094	2093	0-60	4322	83.5	65	1792	1673	1721
	25	1907	1911	1905	0-90	5177	100.0	75	1603	1508	1688
	35	1614	1609	1599				85	1751	1710	1988
	45	1227	1213	1197							
	55	820	791	780							
	65	485	453	466							
75	266	250	280								
85	98	96	111								

2x4 T-Grid LED troffer, 7400 nominal delivered lumens

LER – 96

Catalog No. 2TG74L840-4-FS-02F-UNV Test No. 33536 S/MH 1.2 Lamp Type LED Lumens 7142 Input Watts 74.1 Comparative yearly lighting energy cost per 1000 lumens – \$2.50 based on 3000 hrs. and \$.08 pwr KWH. The photometric results were obtained in the Philips Day-Brite laboratory which is NVLAP accredited by the National Institute of Standards and Technology. Photometric values based on test performed in compliance with LM-79.	Candlepower				Light Distribution			Average Luminance			
	Angle	End	45	Cross	Degrees	Lumens	% Luminaire	Angle	End	45°	Cross
	0	3008	3008	3008	0-30	2309	32.3	45	3729	3684	3643
	5	2994	2997	2999	0-40	3692	51.7	55	3073	2964	2928
	15	2879	2887	2888	0-60	5959	83.5	65	2470	2304	2378
	25	2628	2634	2627	0-90	7140	100.0	75	2210	2076	2330
	35	2224	2217	2205				85	2411	2360	2783
	45	1689	1669	1650							
	55	1129	1089	1076							
	65	669	624	644							
75	366	344	386								
85	135	132	155								

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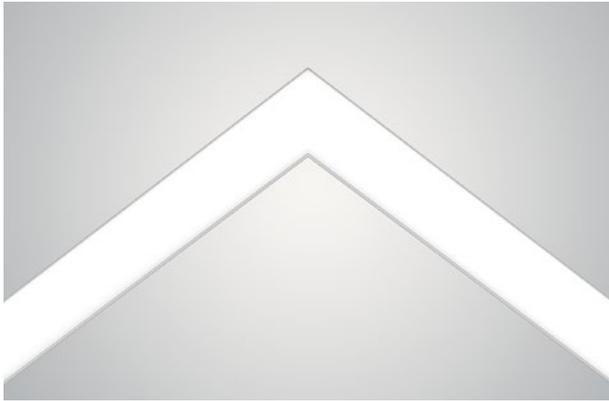


Philips Lighting North America Corporation
200 Franklin Square Drive, Somerset, NJ 08873
Tel. 855-486-2216

Philips Lighting Canada Ltd.
281 Hillmount Rd, Markham, ON, Canada L6C 2S3
Tel. 800-668-9008

MP2053

VIA 3 PATTERNS RECESSED



LEV - leveled corner

DESCRIPTION

At LumenWerx, we make it simple to design patterns customized for you. Whether surface, wall mount, pendant or recessed - or even a combination of different mounting types, we make it easy to achieve the results you're looking for. While our standard is a 90° corner, we can customize angles to suit your needs.

PROJECT: _____

TYPE: _____

NOTES: _____



up to 121 lm/w performance

IC RATED

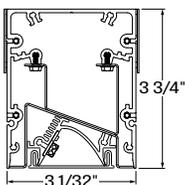
ORDER GUIDE

VIA3RPAT	GRO	LED			
LUMINAIRE ID	OPTICS	LIGHT SOURCE	CRI	LUMEN PACKAGES	COLOR TEMP.
VIA3RPAT - via 3" recessed pattern	GRO - grazing reflector optic	LED - high performance LED	80 - 80CRI 90 - 90CRI	500 - min. low output 500lm/ft 750 - medium output 750lm/ft 1000 - max. high output 1000lm/ft #### - other required lm/ft	30 - 3000k 35 - 3500k 40 - 4000k

PATTERN LENGTH	CORNER TYPE	CORNERS DEGREE	VOLTAGE	DRIVER	ELECTRICAL
#FT - nominal length in feet #IN - length in inches Continuous Run - for luminaires over 12'	INN - inner corner	90 - 90 degrees # - other degrees	120 - 120V 277 - 277V UNV - 120V-277V 347 - 347V (not available with Lutron)	D1 - 1% dimming 0-10V DA - Dali LTEA2W - Lutron 1% - 2 wires 120V LDE1 - Lutron 1% Eco Dim to Off LDE5 - Lutron 5% EcoSystem	1 - 1 circuit +EB - emergency battery (min 4' fixture, except Lutron) +EM - emergency light circuit +NL - night light circuit +GTD### - generator transfer device, 120V or 277V

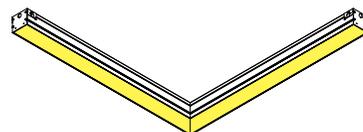
MOUNTING CEILING	MOUNTING WALL	FINISH	CONTROLS	OPTIONS
TG9 - tegular 9/16" TG15 - tegular 15/16" TB9 - t-bar 9/16" TB15 - t-bar 15/16" ST - screw slot t-bar DTR - drywall trim DTL - drywall trimless DMF - drywall mud flange NA - not applicable	DTR - drywall trim DTL - drywall trimless DMF - drywall mud flange NA - not applicable	W - matte white CF# - custom finish specify RAL#	GROUPED CONTROLS LSC - Local system NSC - Network system	FU - fuse FWC - flexible whip cable (6' std) CP - Chicago Plenum CU - custom

CROSS SECTION



VIA3RPAT - recessed

3D VIEW



LEV - leveled corner

TECHZONE™ & USG Compatible





VIA 4 LED

RECESSED



Grid - regressed lens



Drywall - flush lens

DESCRIPTION

Via 4 is the flexible linear LED luminaire system for pendant, surface and recessed or in-wall installation, whether as discrete luminaires, continuous runs or patterns. Via 4 features numerous high-efficiency optical configurations, including separately controlled indirect/direct, wall wash and asymmetric distributions, as well as a wide range of electrical, control and trim options. See separate spec sheets for patterns and other available mountings.

PROJECT: _____
 TYPE: _____
 NOTES: _____



up to 126 lm/w performance

ORDER GUIDE

IC RATED

LUMINAIRE ID	HLO OPTICS	LED LIGHT SOURCE	CRI	LUMEN PACKAGES	COLOR TEMP.
VIA4RF - via 4" recessed flush lens	HLO - High-Efficiency Lambertian Optic	LED - high performance LED	80 - 80CRI 90 - 90CRI	500 - min. low output 500lm/ft	30 - 3000k
VIA4RR - via 4" recessed regressed lens				750 - medium output 750lm/ft	35 - 3500k
				1000 - high output 1000lm/ft	40 - 4000k
				1200 - max. ultra high output 1200lm/ft	
				#### - other required lm/ft	

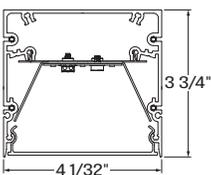
LUMINAIRE LENGTH	VOLTAGE	DRIVER	ELECTRICAL	MOUNTING	FINISH
Standard sections - 2', 3', 4', 5', 8' & 12' For all other specify length	120 - 120V 277 - 277V	D1 - 1% dimming 0-10V DA - Dali	1 - 1 circuit +EB - emergency battery (min 4' fixture, except Lutron)	TG9 - tegular 9/16" TG15 - tegular 15/16"	W - matte white CF# - custom finish specify RAL#
#FT - nominal length in feet #IN - length in inches Continuous Run - for luminaires over 12' Minimum Individual section 2'	UNV* - 120V-277V 347 - 347V (not available with Lutron) * not available with MR16	LTEA2W - Lutron 1% - 2 wires 120V L3DA3W - Lutron 1% - 3 wires L3DAE - Lutron 1% EcoSystem LDE1 - Lutron 1% Eco Dim to Off LDE5 - Lutron 5% EcoSystem	+EM - emergency light circuit +NL - night light circuit +COB/MR - COB/MR circuit +GTD### - generator transfer device, 120V or 277V	TB9 - t-bar 9/16" TB15 - t-bar 15/16" ST - screw slot t-bar DTR - drywall trim DTL - drywall trimless DMF - drywall mud flange	

CONTROLS	LED DOWNLIGHT	COB CRI	COB LUMEN PACK.	COB COLOR TEMP.	COB DRIVER	OPTIONS
INDIVIDUAL CONTROLS OMS - Onboard Occupancy ODS - Onboard Daylight OCS - Onboard Occupancy & Daylight	#COB20 - COB 20° #COB30 - COB 30° #COB40 - COB 40°	80 - 80CRI 90 - 90CRI 97 - 97CRI	600 - 600lm 1200 - 1200lm 1800 - 1800lm	30 - 3000k 35 - 3500k 40 - 4000k	D1 - 1% dimming 0-10V DA - Dali	FU - fuse FWC - flexible whip cable (6' std) CP - Chicago Plenum CU - custom
GROUPED CONTROLS LSC - Local system NSC - Network system	#MR16 - MR16 LED Minimum individual section with downlight 4'	(consult factory)				

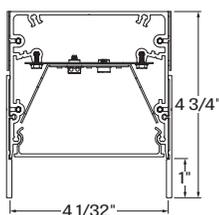
See page 2 for ordering code detailed information

**** dimming driver integral to fixtures ****

CROSS SECTION



VIA4RF - flush



VIA4RR - regress

OPTICS



HLO - High-efficiency Lambertian Optic



VIA 4 LED

RECESSED

OPTICS

HIGH EFFICIENCY LAMBERTIAN OPTIC (HLO) - Matte white side reflectors combined with High-Efficiency Lambertian Optic (HLO) shielding of diffusing 0.075" thick acrylic with up to 88% transmission and good source obscuration. Luminaire brightness is controlled by the flux-to-shielding area ratio.

LIGHT SOURCE - LED

Custom linear array of mid-flux LED's are cartridge-mounted with quick-connect wiring to facilitate service and thermal management. Available in 3000K, 3500K and 4000K with a minimum 80 CRI and an option for 90 CRI with elevated R9 value. Color consistency maintained to within 3 SDCM. LEDs operated at reduced drive current to optimize efficacy and lumen maintenance.

All LEDs have been tested in accordance with IESNA LM-80-08 and the results have shown L80 lumen maintenance greater than 60,000 hours. Absolute product photometry is measured and presented in accordance with IESNA LM-79, unless otherwise indicated.

PERFORMANCE PER 4' AT 4000K

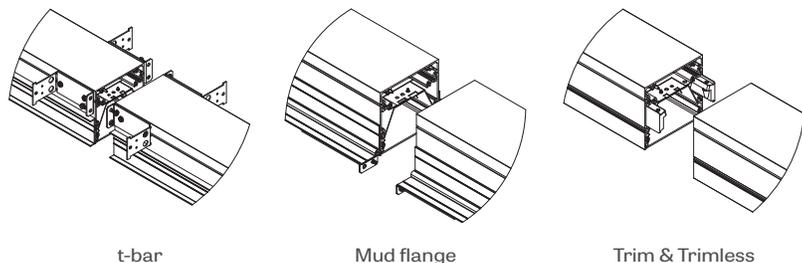
LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
low output	4000K	16	2000	126
medium output	4000K	25	3000	121
high output	4000K	33.5	4000	119
ultra high output	4000K	40.5	4800	118

LUMINAIRE LENGTH

Via 4 is made up of standard 2, 3, 4, 5, 8 and 12 foot sections that may be joined together to create longer continuous run lengths. Exact run length must be noted in the product code. The minimum individual section available is 2 foot, and continuous run lengths can be ordered in 2 inch increments.

All individual sections are joined together onsite using the joiner kits provided. LumenWerx offers joiner kits that are extremely simple to work with in the field and result in a fixture that appears virtually seamless with no light leak at any connection.

Joining system



ELECTRICAL

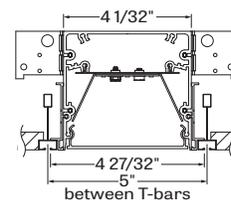
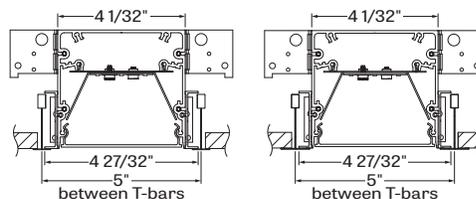
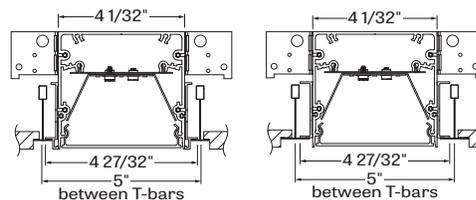
Factory-set adjustable output current electronic driver with 120-277V AC line input. Dimmable from 100% to 1% with 0-10V control. Rated life (90% survivorship) of 50,000 hours at 50°C max. ambient (and 70°C max. case) temperature. At maximum driver load: Efficiency > 84%, PF > 0.9, THD < 20%. Other specifiable options include Lutron Hi-Lume A (specify 2, 3 or 4 wires), EcoSystem H (100%-1%, fade-to-black) and EcoSystem 5 (100%-5%) dimmable drivers and DALI protocol drivers.

EMERGENCY

Factory installed long life high temperature recyclable Ni-Cad battery pack with test switch and charge indicator; minimum of 90 minutes operation, up to 1000 lumens per 4ft (25°C) emergency lighting output. Recharge time of 24 hours.

MOUNTING OPTIONS

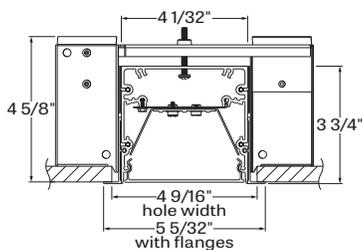
Recess mount into exposed or concealed T-Bar or Tegular grid ceiling



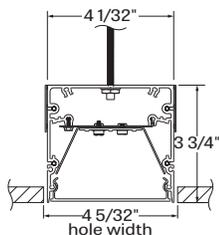
VIA 4 LED

RECESSED

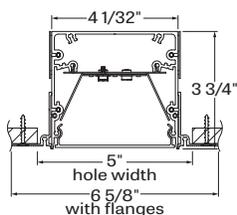
Mounting for drywall ceilings are available with visible trim, mud flange, trim or trimless



DTR - drywall trim



DTL - drywall trimless



DMF - drywall mud flange

FINISH

Interior - 95%, reflective matte powder coated white paint

Exterior - matte white powder coating.

Custom finishes are also available.

CONTROLS

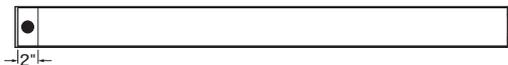
LumenWerx offers several options for integrating occupancy and daylight controls. Whether a sensors control its own fixture or is part of a group of fixtures, lights can be automatically controlled according to different energy saving strategies.

With **individual Controls**, an on-board sensor controls the fixture in which it is installed. Depending on the length, more than one sensor may be necessary and may control the entire fixture, or just a section.

With **Grouped Controls**, on-board or remote sensor are part of a either a local or network sensor infrastructure. It's possible to scale the controls, from a switch to a fixture setup, to a room or a whole building Occupancy and or daylight harvesting.

INDIVIDUAL CONTROLS

Individual controls are integrated into the fixture and are therefore easy to use and allow for a cleaner looking space as no ceiling or wall-mounted sensors are required. Individual controls can be one of three types (**OMS**) Occupancy, (**ODS**) Daylight Harvesting (Photocell), or (**OCS**) combined occupancy and daylight harvesting. These controls will be installed with factory settings, but most offer field adjustability with regular tools or manufacturer supplied configuration tools.



Location of an Onboard control

GROUPED CONTROLS

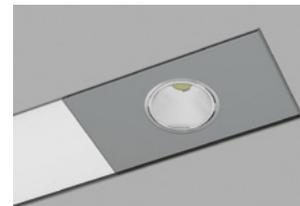
Local systems permit added flexibility and interconnectivity. Each fixture can now become part of a group of fixtures and be controlled by On-Board or remote sensors as well as wireless switches or controllers. With this architecture, it is now possible to have fewer fixtures with On-Board sensor which control all of the fixtures of the lighting zone. In order to have grouped controls programmed in factory, it is required that a floor layout with requested grouping and functionality be supplied. Field commissioning is also possible but must be requested and discussed before final Purchase Order is placed.

Network Controls, Lumenwerx fixtures are compatible with most popular BMS integration protocols such as DALI, DMX, EnOcean, BACnet, Enlighted and Lutron Ecosystem just to name a few. Field commissioning is usually required and details must be discussed before final Purchase Order is placed.

Please contact our controls department at controls@lumenwerx.com for further assistance.

LIGHT SOURCE - COB

Fixtures with Chip On Board (COB) technology are able to provide a maximum output of 1800 lumens from a discrete 50mm aperture on 8 inch centers. Standard



Chip On Board (COB)

CRI is 80, for 90 and 97 CRI with elevated R9 values please consult factory. Standard 20°, 30° and 40° beam angles are available, as are custom angles with prior factory approval. All our Chip-On-Board products have been tested in accordance with IESNA LM-80-08 and the results have shown L80 lumen maintenance greater than 50,000 hours.

LIGHT SOURCE - MR16

Our MR16 option is a replaceable bulb solution which allows for up to a 50W halogen equivalent solution.

VIA 4 LED

RECESSED

CONSTRUCTION**Housing** - Extruded Aluminum (0.095" nominal) up to 90% Recycled Content**Interior brackets** - Die formed cold rolled sheet steel 18 gauge thick**Joining system** - Die cast Zinc (0.95" nominal) and die Formed galvanized sheet 18 gauge**Reflectors** - Cold rolled steel 0.024" thick precisely die formed, 95% reflective matte white painted**Recessed flanges** - Extruded Aluminum (0.075" nominal) up to 90% Recycled Content**Mud flange** - Extruded Aluminum (0.075" nominal) up to 90% Recycled Content**Slip-through bracket** - Die Formed galvanized sheet 18 gauge**End plate** - Die formed cold rolled sheet steel 18 gauge thick**WEIGHT****Via 4 4ft** - 11.23lbs - 5.1kg**Via 4 8ft** - 22.47lbs - 10.2kg**Via 4 12ft** - 33.70lbs - 15.3kg**CERTIFICATIONS****ETL** - Rated for Indoor Dry/Damp locations. Conforms to UL Standard 1598 and certified to CAN/CSA Standard C22.2 No. 250.0.**DLC** - Testing to DLC requirements, for this product, have been completed by an Accredited Laboratory and certified by DLC.**Lighting facts** - testing products and reporting performance results according to industry standards.**Chicago plenum** - City of Chicago Approved (CCEA)**IC rated** - suitable for direct contact with insulation.**WARRANTY**

LumenWerx provides a five-year limited warranty of electrical and mechanical performance of the luminaires, including the LED boards, drivers, and auxiliary electronics. LumenWerx will repair or replace defective luminaires or components at our discretion, provided they have been installed and operated in accordance with our specifications. Other limitations apply, please refer to the full warranty on our website.

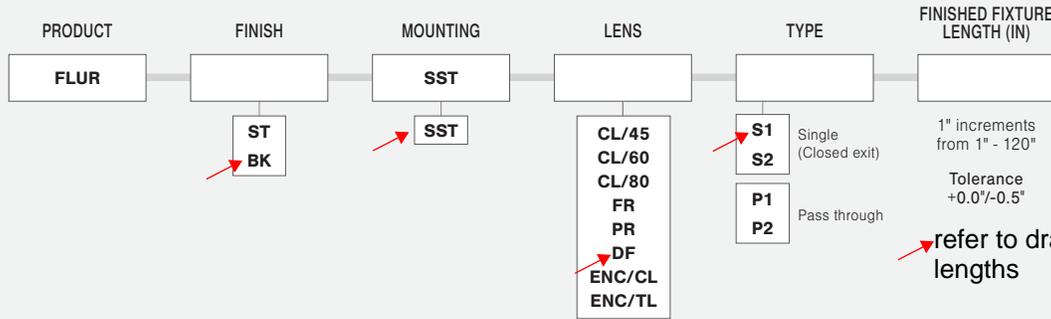


FLUR

TYPE L102 series

AUERBACH · GLASOW

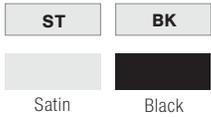
EXTRUSIONS - ALUMINUM (iQA)



refer to drawings for lengths

- NOTES:**
- UL Listed when assembled with STRIP LEDs at Q-Tran
 - NRTL Listed for install in Storage Areas with Clothing, NEC Field 410.2 and 410.16 when assembled as a fixture, with 4.0 w/ft or less, at Q-Tran facility (Not applicable for encapsulation)
 - Field modifications must comply with Q-Tran's installation methods otherwise warranty is null and void
 - Recess mounted with adhesive only

FINISH



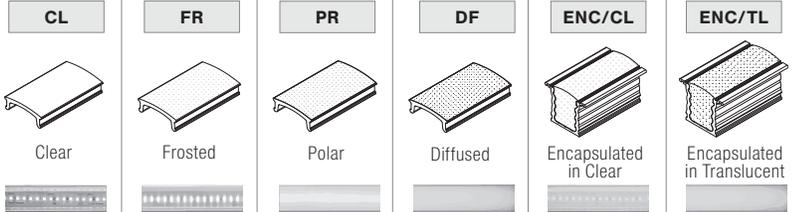
MOUNTING

NOTE: 2 clips provided per first 2'; 1 clip provided per additional 1'

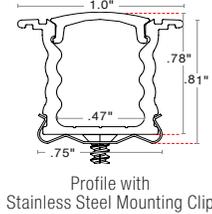
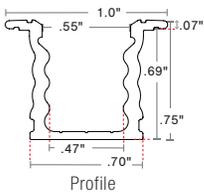


QTY:

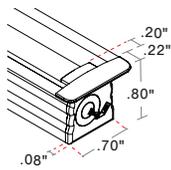
LENS with LED visibility



DIMENSIONS



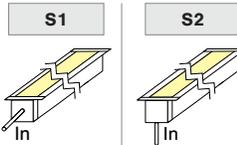
END CAPS



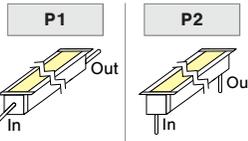
QTY:

TYPE

SINGLE (Input only)



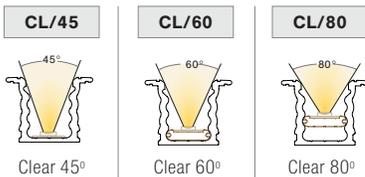
PASS THROUGH (Input/Output)



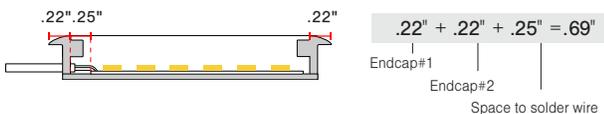
ORDER EXAMPLE



CUT OFF



LENGTH (IN)



PROJECT NAME	DATE	COMPANY	TYPE	NOTE

SW24/3.0

TYPE L102 series

AUERBACH·GLASOW



STRIP - STATIC WHITE

V/WATTS	RATED	CCT - LUMENS/CRI	³ CONNECTOR/ WIRE IN	³ CONNECTOR/ WIRE OUT	ILLUMINATED LENGTH (IN)
SW24/3.0 Voltage: 24 VDC Wattage: 3.0 W/Ft					refer to drawings for lengths
	DRY	20 - 2000K 230/94 24 - 2400K 245/94 27 - 2700K 255/95 30 - 3000K 269/95 35 - 3500K 287/96 40 - 4000K 300/96	1 BW BRL CLS	1 BW BRL CLS	2 1"-384" OR 3 MATCH 1" increments Matches EXT length ordered
	DMP	24 - 2400K **** 27 - 2700K 244/99 30 - 3000K 252/98 35 - 3500K 249/95 40 - 4000K 270/96	1 BW BRL	1 BW BRL CLS	2 1"-180" OR 3 MATCH 1" increments Matches EXT length ordered
	4 ENC				3 MATCH Matches EXT length ordered
	WET	20 - 2000K **** 24 - 2400K 227/95 27 - 2700K 230/95 30 - 3000K 242/95 35 - 3500K 262/96 40 - 4000K 275/96	1 BW BRL	1 BW BRL CLS	2 1"-360" OR 3 MATCH 1" increments Matches EXT length ordered

ENC RATED STRIP ARE NOT FIELD CUTTABLE

NOTES:

- Field modifications must comply with Q-Tran's installation methods otherwise warranty is null and void
- All data has +/- 5% tolerance
- 5 year warranty
- NRTL Listed for install in Storage Areas with Clothing, NEC Field 410.2 and 410.16 when assembled as a fixture, at Q-Tran facility (Not applicable for encapsulation)

- 1 Custom Bare Wire length up to 120" - request different length by writing it in inches next to "BW" in the order code box
- 2 See resource guide for light loss factor
- 3 Wire orientation for MATCH will be dictated by extrusion Feed In/Feed Out selection
- 4 If ordering an encapsulated extrusion, ENC (Encapsulated in Extrusion) must be chosen for your strip

TECHNICAL INFORMATION [L70 = 30000 HRS]

*Tested with SW24/3.0-DRY

CCT	Lumen/ft	CRI Ra	CRI R9	TM30 Rf	TM30 Rg
2000K	230	94	65	86	107
2400K	245	94	98	93	103
2700K	255	95	96	94	102
3000K	269	95	92	93	102
3500K	287	96	88	91	101
4000K	300	96	89	90	100

DIMENSIONS



Section (in)	DRY	DMP	WET
A	0.32"	0.32"	0.47"
B	0.16"	0.16"	0.16"
C	1.00"	1.00"	1.00"
D	0.06"	0.12"	0.21"

CONNECTOR/WIRE IN

1 BW	BRL	CLS
Bare Wire 24"	Male Barrel 6"	Not soldered DRY ONLY

CONNECTOR/WIRE OUT

1 BW	BRL	CLS
Bare Wire 24"	Female Barrel 6"	Not soldered

PROJECT NAME	DATE	COMPANY	TYPE	NOTE



Remotely located dimming driver

QTM-DC+CAP

TYPE L102 series

AUERBACH · GLASOW

Q-Tran has developed several products to power constant voltage LED products; including 12VDC and 24VDC linear products (like ribbon light and other linear technologies). The benefit of using the Q-Tran magnetic LED power supply is that our product can be controlled with a standard, forward-phase control dimmer known as a Magnetic Low Voltage dimmer (MLV). We now have available, and CSA listed to UL 2108 standard, 3 product categories that include a good way, a better way and the best way to power these types of LED products.

HOUSING

- 18 gauge Welded Steel Enclosure: 14.5"W x 8.00"H x 4.00"D
- Door: 15.5"W x 9.00"H
- Knockouts: 25
- Built-in support bracket incorporated to secure housing for surface mounting

MULTI-VOLT & TAPS

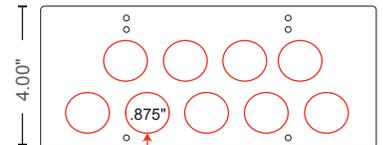
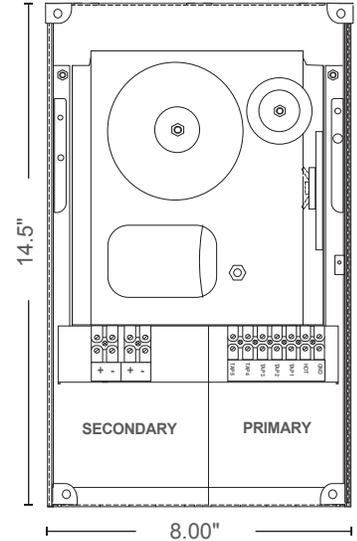
- Primary Taps: All units come standard with primary circuit protection
- Five (5) primary taps provide:
 - 12VDC** : 12, 13, 14, 15, 16
 - 24VDC** : 24, 26, 28, 30, 32
- Loads may be connected to one (1) of the primary taps up to the full watt rating of the PSC.
- No de-rating required.
- The advantage is that loads at varying distances from the PSC can be tapped to recover voltage drop and produce between 85%-100% light output. (See Q-TRAN Voltage drop Calculator)
- Secondary Circuit Protection: 1-2 magnetic circuit breakers.

TOROIDAL CHOKE

Q-Tran's Standard Choke, or "Debuzzing Coil" reduces noise when dimming and helps negate in-rush current that is prevalent with LED loads. It allows for quiet operation and eliminates nuisance tripping.

LOW VOLTAGE LIGHTING POWER SUPPLY

- TESTED TO UL 2108 STANDARD
- WALL MOUNT/ROD SUSPENSION
- FOR SUPPLY CONNECTIONS USE WIRE RATED FOR AT LEAST 75°C
- SUITABLE FOR DAMP LOCATIONS
- USE DIMMERS RATED FOR MAGNETIC LOW VOLTAGE LOAD WITH NEUTRAL WIRE
- ISOLATION TOROIDAL TRANSFORMER
- 50/60 CYCLE
- MADE IN THE U.S.A.



9 Knockouts of 0.875" Hole for 1/2" fitting

NOTE: 16 additional side knockouts

ORDERING GUIDE

Model	1 Size	2 Prim. V	3 Sec	4 No	5 Brk Amp	6 Choke	7 Opts
QTM	-	-	/	-	x	+ CK-S	+
1 Size		Max Load (Watts)	Secondary Voltage(12/24VDC)	Max Prim. Amps@120V	Max Prim. Amps@277V		
60DC+CAP	60W	12VDC	0.9 A	0.4 A			
120DC+CAP	120W	12VDC	1.4 A	0.6 A			
60DC+CAP	60W	24VDC	0.9 A	0.4 A			
100DC+CAP	100W	24VDC	1.3 A	0.5 A			
120DC+CAP	120W	24VDC	1.4 A	0.6 A			
200DC+CAP	200W	24VDC	2.4 A	1.0 A			
2 Primary Voltage		120V(60Hz)	220V(50/60Hz)*	230V(50/60Hz)*	240V(50/60Hz)*	277V(60Hz)	
3 Secondary Voltage		12VDC	24VDC				
4 Number of Breakers		1-2					
5 Secondary Breaker Amperage		AMPS	Max 12V Load	Max 24V Load	7 Options		
2.5	30W	60W	WH White (Standard)				
4	48W	96W	BK Black Powder Coat Finish				
5	60W	120W					
6 Choke		CK-S: 60W-200W Standard					
Ordering Example							
QTM-60DC+CAP-120/24-1x2.5+CK-S							

*Not Standard, Call Factory For options

2017.V02

PROJECT NAME	DATE	COMPANY	TYPE	NOTE

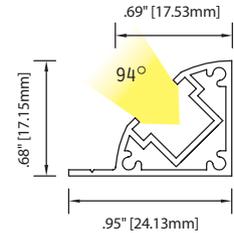
1QL QUARTER ROUND EXTRUSION - LENSED

1QL: IP40 | Quarter Round extrusion fits snugly into corners for bright, even linear lighting. UL Listed dry/damp. Includes Nichia LEDs in choice of 11 LED Board options. See lumen outputs, CCTs, wattage and other variables on Linear Fundamentals.

Available in Silver, Black or Bronze Anodized, White Powder Coated, or Custom Finishes. Choice of Clear Acrylic lens (standard), 3 Opal diffusion lenses, or four focusing lenses L2 (18° - 31°), L3 (30° - 42°) or Lens 4 (78° - 82°). Photometrics vary based on CCT and lensing; see vltcorp.com for output conversion and other data specific to your fixture choices.



(Beam Angle based on 1QL fixture with Clear Acrylic lens)



ELL- 1QL - _____ - _____ - _____ - _____ - _____ - _____

LED		CCT		Finish		Lens Options ²		Wire Exit ³		Listings	
1720	260 lm/ft, 1.8 w/ft, 83 CRI	20	2000°K	AL	Silver Anodized	PG	Clear Acrylic	C	Custom	UL	UL Listed
2730	397 lm/ft, 2.9 w/ft, 83 CRI	22	2200°K	BL	Black Anodized	L2	Lens 2 (18° - 31°)			CE	CE Marked (RoHS)
4740	528 lm/ft, 3.7 w/ft, 83 CRI	25	2500°K	BZ	Bronze Anodized	L3	Lens 3 (30° - 48°)				
5760	665 lm/ft, 4.9 w/ft, 83 CRI	27	2700°K	WH	White Powder Coat	L4	Lens 4 (78° - 82°)				
6760	875 lm/ft, 6.5 w/ft, 83 CRI	30	3000°K	C	Custom	OP1	Opal 1, Frosted				
3720	223 lm/ft, 1.8 w/ft, 95 CRI	35	3500°K			OP2	Opal 2, Medium				
3740	430 lm/ft, 3.5 w/ft, 95 CRI	40	4000°K			OP3	Opal 3, Heavy				
3760	609 lm/ft, 5.2 w/ft, 95 CRI	45	4500°K								
3790	621 lm/ft, 6.9 w/ft, 98 CRI ¹	50	5000°K								
5133	315 lm/ft, 3.4w/ft, 87 CRI ¹										
5163	548 lm/ft, 6.6w/ft, 87 CRI ¹										

³ Because of 1QL's asymmetric form, special care should be taken when specifying Wire Exit

² See Lensing Options for more information

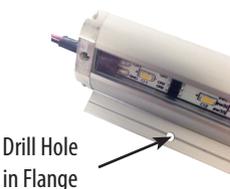
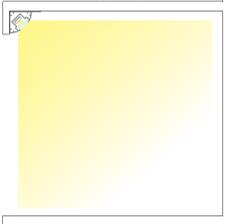
Fixture Length

See Fixture Length and Wattage Table. Choose the correct Code number for the LED board and fixture length of your choice or specify Custom Length as follows: C (12.25") or C [311mm]

Standard HI CRI Pitchless Ultra HI CRI

¹ Not Available in 20K, 22K or 25K CCT

1QL tucked behind lighting valance

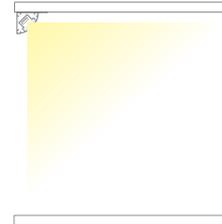


Drill Hole in Flange

1QL's self-contained mounting flange allows the fixture to fit tightly into corners, with a 94° beam angle and wide field angle for fully lighting shelf and undercabinet spaces. 1QL can tuck neatly behind a lighting valance, as illustrated at left, or if no valance is provided, 1QL can mount flush with the front edge of the shelf or cabinet. The fixture's slim, finished back surface ensures an attractive presentation, as shown in the photos to the right. With black, white, silver, bronze or custom finish options, 1QL can blend in with or accent a wide range of cabinetry finishes.

The 1QL flange is scored for easy drilling; mounting holes should be drilled approximately every 20" (minimum two holes per fixture). The 1QL fixture can also be mounted using VHB tape.

1QL mounted on shelf edge



When visible, the slim 1QL fixture adds an attractive accent to cabinetry



DIMMING & CONTROLS

Notes on Dimming and Controls: EssentialLED® products can be dimmed using any of the **self-contained** dimming drivers offered on the previous pages, **OR** by combining **Osram's 0-10v Dimming Module** with any of our constant voltage electronic drivers. All self-contained dimming drivers (marked with an orange dot (●)) require a Relay Module (AC - PWR - RLY) to reach full "off" position. Magnetic drivers can be dimmed using a standard magnetic low voltage wall dimmer.

Whether you choose a self-contained dimming driver, or combine a 0-10v dimming module and standard driver, you will need a device to control the dimming effect. We offer the wall-mount **Lutron Diva** or a **Local Dimming Controller** that attaches directly to the driver unit.

CONTROL & INTERFACE ACCESSORIES

0 - 10V/ DMX DIMMING MODULE	SPECIFICATIONS	CAT. NO. AC - PWR -
 <div style="text-align: right;">  </div>	<p>Dimensions: 6.77" L x 1.65" W x 0.79" H [172mm L x 42mm W x 20mm H]</p> <p>Weight: 0.165lbs [74.84 grams]</p> <p>Nominal Input Voltage: 24</p> <p>OT DIM Max.Output Power (W): 120w, 60w each output, 2 channels</p> <p>OT DMX Max.Output Power (W): 140w, 48w each output, 3 channels</p> <p>OT DIM Max Output Current per Channel (A): 2.5 A</p> <p>OT DMX Max Output Current per Channel (A): 2.0 A</p> <p>Output Frequency (Hz): 135</p> <p>Input Voltage Range: 9.5 - 25v DC</p> <p>Dimming Range: 0 - 100%</p> <p>Control Current: 0.6 mA max.</p> <p>Temp. Range: 4° to 122°F [-20° to +50°C]</p> <p>Max. Case Temperature: 158°F [70°C]</p> <p>Manufacturer: Osram</p>	<div style="border: 1px solid black; padding: 2px; text-align: center;"> DIM DMX </div> <p>Description: 0 - 10v dimming module from Osram for use in conjunction with standard electronic drivers (Constant Voltage only); requires control device. Two outputs of 60w each, 120w max.</p>
<p>LUTRON DIVA 0 - 10V CONTROL</p>  <div style="text-align: right;">   </div>	<p>SPECIFICATIONS</p> <p>Dimensions: 4.69" L x 0.94" W x 0.30" H [119mm L x 75mm W x 7.6mm H]</p> <p>Control: 0-10v 30 mA</p> <p>Manufacturer: Lutron</p> <p>Finish Color: White</p>	<p>CAT. NO. AC - PWR - 4WF</p> <p>Description: Control device from Lutron for control of 0 - 10v dimming; can be used in conjunction with OT Dim module and standard electronic driver (Constant Voltage only) or with self-contained dimming drivers (Constant Voltage or Constant Current). Wall mount paddle switch with linear slide; uses low-voltage wiring for easy installation. White.</p>
<p>MOTION SENSOR</p>  <div style="text-align: right;">  </div>	<p>SPECIFICATIONS</p> <p>Dimensions: 3.00" L x 1.75" W x 1.38" H [76.2mm L x 44.5mm W x 34.9mm H]</p> <p>Material: Plastic Case</p>	<p>CAT. NO. AC - PWR - MO</p> <p>Description: Mini PIR Motion Sensor switch automatically powers on LEDs for 1 to 10 minutes (variable setting); 6 amp maximum load; detection range of 15 feet, 60° from center of sensor.</p>
<p>DOOR/DRAWER PRESSURE SWITCH</p>  <div style="text-align: right;">   </div>	<p>SPECIFICATIONS</p> <p>Dimensions: 1.50" L x 1.63" W x 0.56" H [38.1mm L x 41.3mm W x 14.3mm H]</p> <p>Material: Plastic Case</p>	<p>CAT. NO. AC - PWR - PSW</p> <p>Description: Pressure Switch mechanically connects/disconnects wire connection to automatically power LEDs when cabinet door or drawer is opened. Mount inside so that plunger is held in off position when door/drawer is closed.</p>

CONTROL & INTERFACE ACCESSORIES

LOCAL DIMMING CONTROLLER	SPECIFICATIONS	CAT. NO. AC - PWR - KNB
--------------------------	----------------	-------------------------



CV
CC

Dimensions: 1.5" Diameter; 4.5" wire lead
[38.1mm Diameter;
114.3 mm wire lead]
Material: Plastic Case

Description: Local dimming control device for 0-10v dimming; use in conjunction with 0 - 10v dimming module (Cat. No. AC - PWR - DIM) (Constant Voltage only) or in conjunction with self-contained dimming drivers (Constant Voltage or Constant Current.)

LUTRON RELAY MODULE	SPECIFICATIONS	CAT. NO. AC - PWR - RLY
---------------------	----------------	-------------------------



CV

Dimensions: 3.75" L x 2.25" W x 1.38" H
[95.3mm L x 57.15mm W x 35.05mm H]
Manufacturer: Lutron

Description: Power Relay Module from Lutron for use with electronic self-contained 0 - 10v dimming drivers; shuts input power to full "off".

UNIVERSAL DMX DIMMING INTERFACE - CONSTANT VOLTAGE	SPECIFICATIONS	CAT. NO. AC - PWR - PB -
--	----------------	--------------------------



CV

Dimensions: 11.5" L x 6.0" W x 1.89" H
[292mm L x 152mm W x 48mm H]
Weight: 3lbs [1.4kg]
Input Voltage: 12v-24vDC
Input Current: 4A max.
Output Voltage: 12v-24vDC
Output Current: 4A max.
Dimming Method: Eldoled Hydra Driver
Dimming Range: 100%-0%
Control Protocol: DMX
DMX In/Out: Neutrik Ether Con
DMX Channels: 1 or 2
Temp. Range: -4° to 122°F [-20° to +50°C]
Tc Max: 149°F [65°C]
Manufacturer: VLT

DMX1
DMX2

Description: Low Voltage DMX dimming Interface module, 12v to 24c DC input Constant Voltage, 8 Amp Max Output Current, allows for any LED driver to dim using the EldoLed Hydra Drive dimming technology. Flicker Free dimming to dark, 0 - 100% dimming range, DMX Controllable, DMX In / DMX Out Connectors, 1 or 2 DMX Control Channels.

UNIVERSAL DMX DIMMING INTERFACE - CONSTANT CURRENT	SPECIFICATIONS	CAT. NO. AC - PWR - PB - DMXCC
--	----------------	--------------------------------



CC

Dimensions: 11.5" L x 6.0" W x 1.89" H
[292mm L x 152mm W x 48mm H]
Weight: 3lbs [1.4kg]
Input Voltage: 12v-32v
Input Current: 4.62A max
Output Voltage: 11v-31v
Output Current: 200mA-1,050mA (Programmable)
Dimming Method: Eldoled Hydra Driver
Dimming Range: 100%-0%
Control Protocol: DMX
DMX In/Out: Neutrik Ether Con
DMX Channels: 1
Temp. Range: -4° to 122°F [-20° to +50°C]
Tc Max: 149°F [65°C]
Manufacturer: VLT

Description: Low Voltage DMX dimming Interface module 200mA - 1050mA, Constant Current, 12v to 32V DC input, 4 Amp Max Output Current, 4 Chanel, allows for any LED driver to dim using the EldoLed Hydra Drive dimming technology. Flicker Free dimming to dark, 0 - 100% dimming range, DMX Controllable, DMX In / DMX Out Connectors, 1 DMX Control Channels.

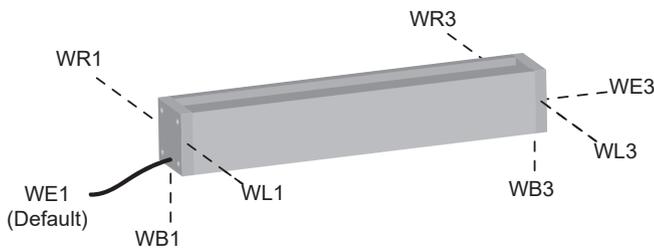
WIRE EXITS & DAISY CHAINED FIXTURES

SQUARE EXTRUSIONS

- ML1*
- 1S*
- 4SL
- 7SL
- 8SL
- 8CL
- 8FL
- 9SL
- 5SLW*
- LR
- MLR*

*(ML1, 1S, 5SLW & MLR extrusions available with WE1 or WE3 options ONLY.)

(LR = LightRun, MLR = Mini LightRun)



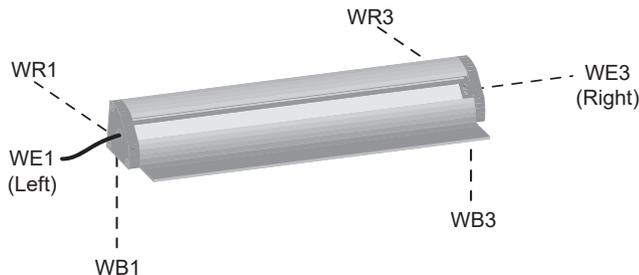
ROUND EXTRUSIONS

- 1R
- 2RL
- 3RL



QUARTER ROUND EXTRUSION

- 1QL
- 2QL



DEMI-ELLIPSE EXTRUSION

- 1EL



To Specify "Daisy-Chained" Configurations: In certain applications, "Daisy-Chained" configurations provide the best wiring solution. Specify the following "Daisy-Chain Termination" Modification for EVERY fixture needing to be daisy-chained; refer to the correct diagrams above for available Wire Exit options: See example below. Daisy-Chained lengths CANNOT exceed a TOTAL of 88 watts per run! (Choice up to 44 watts.)

DAISY-CHAIN TERMINATION

Specify two wire exits, two wire lengths, and two connectors for each fixture to be daisy-chained.

Sample specification: ELL - AC - DCT - WE1 - 2" - NC / WE3 - 2" - NC



LEFT SIDE				RIGHT SIDE			
CAT. NO.	ELL - AC -	-	-	/	-	-	-
DCT	ASWE	WE1	WR1	Wire Length in Inches	NC	MC	FC
		WL1	WL1				
		WB1	WB1				
					WE3	WR3	WR3
					WL3	WL3	WL3
					WB3	WB3	WB3
					Wire Length in Inches	NC	MC
							FC

NC	No Connector
MC	Male Connector
FC	Female Connector

SPECIFICATIONS

STEP



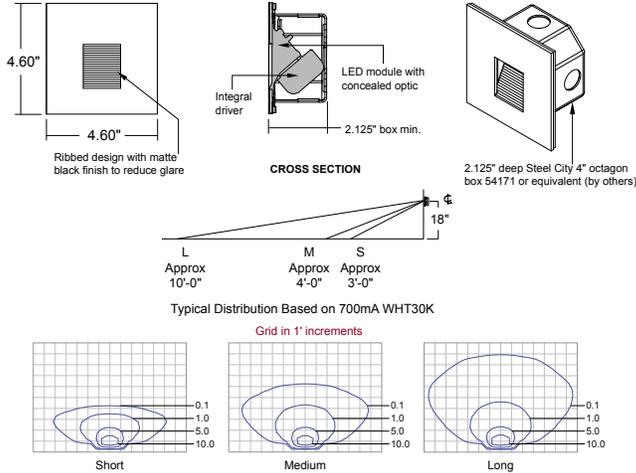
STEP 12

SQUARE

Type:

Project:

Qty:



Construction

Die-cast housing with solid aluminum, brass, or stainless steel faceplate. Step12 is a surface mount step light that mounts over a Steel City 2-1/8" deep, 4" octagon box 54171 or equivalent (by others) without visible fasteners.

Source

Light source is a single powerful LED available in five white color temperatures and six colored LED choices.

Optics

Concealed optic is available in three light distribution patterns. Short for narrow corridors, Medium for wide corridors, and Long for large area illumination.

Electrical

Integral electronic drivers are multi volt input 120-277V, and available in standard or 0-10V dimming. Non-dimming units consume 2.5W (350mA). Dimming units consume 4W (350mA only).

Environment

ETL / cETL listed dry location only.

Finish

Recessed surfaces have a ribbed design with matte black finish to reduce glare. Faceplates are available in five metal finishes with protective clear coat or one of seven polyester powder coat painted finishes. A primer only finish is also available for field painting.

Warranty

5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Assembled in America (Buy American Act Compliant)

Performance Data

Dist.	Lumens	Lm/W
Short	25	10.0
Medium	30	12.0
Long	38	15.2

Performance data based on WHT30K non dimming.

CATALOG NUMBER

Example: **STEP12 SQU L LST1A 350MA WHT30K MVOLT BA**

Series	Faceplate Shape	Distribution	Source	Drive Current	Color Temperature
STEP12 Step 12	SQU Square	S Short M Medium L Long	LST1A LED Step 1	350mA 350 Milliamps	WHT27K White (27K) BLU Blue ¹ WHT30K White (30K) GRN Green ¹ WHT35K White (35K) RED Red ¹ WHT40K White (40K) CYN Cyan ¹ WHT50K White (50K) RDO Red-Orange ¹ AMB Amber ¹
Voltage	Driver	Finish	Special		
MVOLT Multi Volt 120V thru 277V	(Blank) Standard Driver DMD Dimming Driver (350mA only)	BA Brushed Aluminum BB Brushed Brass BSS Brushed Stainless Steel PB Polished Brass PSS Polished Stainless Steel ABP Antique Brass Paint BBP Brushed Brass Paint LBPS Light Bronze Paint Smooth LSP Light Silver PGP Pale Gold SGB Semi Gloss Black SGW Semi Gloss White PRM Primer Only CPF* Custom Paint Finish CMF* Custom Metal Finish	MOD ² Modification / Consult Factory DIM VIA DMX SIGNAL DIMMING DRIVER AND DMX COMPATIBLE DIMMING MODULE IS REMOTELY LOCATED		

Describe Modification:



Notes

- 1 350m.
- 2 Availa

STEP12

SQUARE

Type:

Project:

Qty:

WIRING & DIMMING

POWER SUPPLY / DIMMING

Dimming drivers require a 0-10V fluorescent-type dimming control.

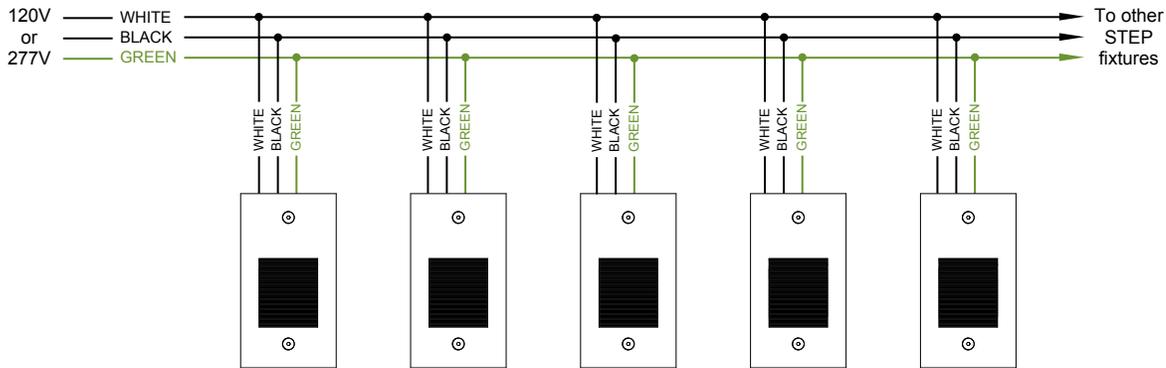
Read all instructions before installation. Do not make live connections!

NON-DIMMING INSTALLATIONS

Connect STEP WHITE wire to power NEUTRAL.

Connect STEP BLACK wire to power HOT.

Connect STEP GREEN wire to power GROUND.



DIMMING INSTALLATIONS

The integral dimming driver is designed to the 0-10V IEC dimming specification 60929 and is compatible with common 0-10V dimmers and dimming systems.

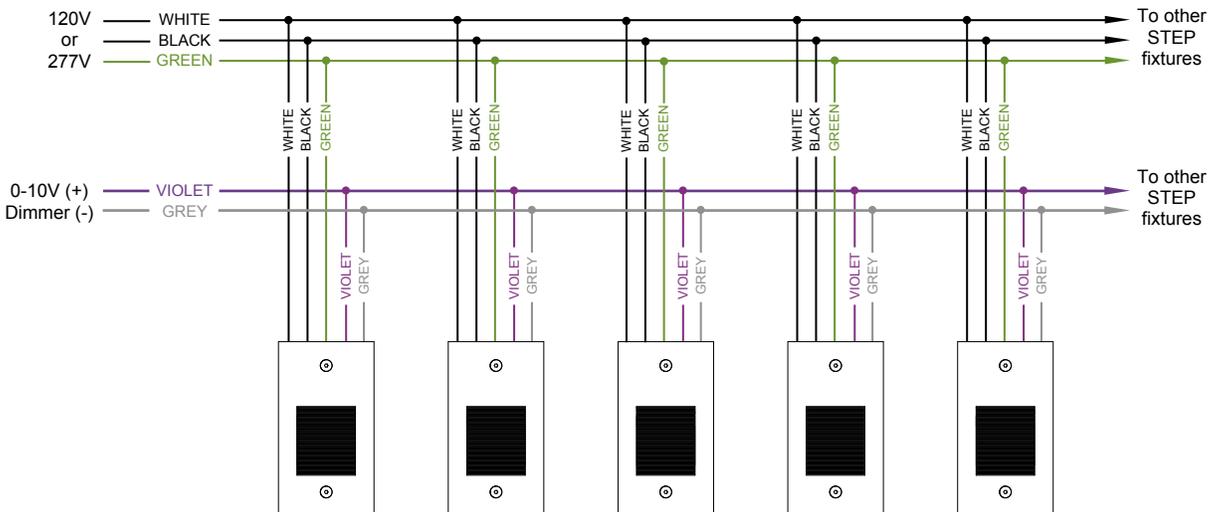
Do NOT connect line voltage to dimming input wires.

Connect STEP WHITE wire to power NEUTRAL.

Connect STEP BLACK wire to power HOT.

Connect STEP VIOLET wire to POSITIVE INPUT of Dimming Control.

Connect STEP GREY wire to NEGATIVE INPUT of Dimming Control.



SPECIFICATIONS

STEP



STEP 13

6-LONG

Type:

Project:

Qty:

Construction

Die-cast housing with solid aluminum, brass, or stainless steel faceplate. Step13-6 is a surface mount step light that mounts over a Steel City 2-1/8" deep, rectangular box 4G4D or equivalent (by others). Interior option faceplate mounts with no visible fasteners.

Source

Light source consists of four powerful LEDs available in five white color temperatures & six colored LED choices.

Optics

A concealed optic provides a long light distribution for illumination of large areas.

Electrical

Integral 0-10V, 5% dimming, constant current driver, 120-277Vac, 47-63Hz. Non-Dimming & Dimming units consume 8 watts.

Environment

ETL / cETL listed dry location or optional wet location.

Finish

Recessed surfaces have a ribbed design with matte black finish to reduce glare. Faceplates are available in five metal finishes with protective clear coat or one of seven polyester powder coat painted finishes. A primer only finish is also available for field painting.

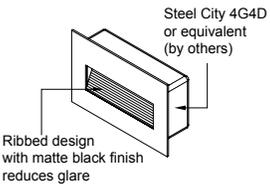
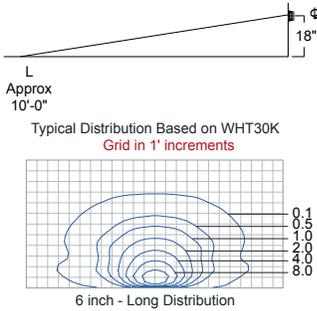
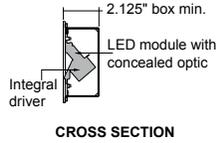
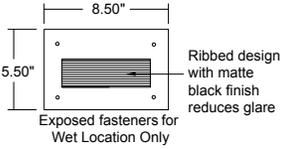
Warranty

5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Assembled in America (Buy American Act Compliant)



CATALOG NUMBER

Example: STEP13 INT 6LONG L LST2A WHT30K MVOLT BA

Series	Environment	Length	Distribution	Source	Color Temperature																								
STEP13 Step 13	WL Wet Location INT Interior	6LONG 6 inch nominal length	L Long	LST2A LED Step 2	<table border="0"> <tr> <td>WHT27K</td> <td>White (27K)</td> <td>BLU</td> <td>Blue</td> </tr> <tr> <td>WHT30K</td> <td>White (30K)</td> <td>GRN</td> <td>Green</td> </tr> <tr> <td>WHT35K</td> <td>White (35K)</td> <td>RED</td> <td>Red</td> </tr> <tr> <td>WHT40K</td> <td>White (40K)</td> <td>CYN</td> <td>Cyan</td> </tr> <tr> <td>WHT50K</td> <td>White (50K)</td> <td>RDO</td> <td>Red-Orange</td> </tr> <tr> <td>AMB</td> <td>Amber</td> <td></td> <td></td> </tr> </table>	WHT27K	White (27K)	BLU	Blue	WHT30K	White (30K)	GRN	Green	WHT35K	White (35K)	RED	Red	WHT40K	White (40K)	CYN	Cyan	WHT50K	White (50K)	RDO	Red-Orange	AMB	Amber		
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Voltage	Driver	Finish	Special																																				
MVOLT Multi Volt 120V thru 277V	<table border="0"> <tr> <td>(Blank)</td> <td>Standard Driver</td> </tr> <tr> <td>DMD</td> <td>Dimming Driver</td> </tr> </table>	(Blank)	Standard Driver	DMD	Dimming Driver	<table border="0"> <tr> <td>BA</td> <td>Brushed Aluminum</td> <td>ABP</td> <td>Antique Brass Paint</td> <td>SGB</td> <td>Semi Gloss Black</td> </tr> <tr> <td>BB</td> <td>Brushed Brass</td> <td>BBP</td> <td>Brushed Brass Paint</td> <td>SGW</td> <td>Semi Gloss White</td> </tr> <tr> <td>BSS</td> <td>Brushed Stainless Steel</td> <td>LBPS</td> <td>Light Bronze Paint Smooth</td> <td>PRM</td> <td>Primer Only</td> </tr> <tr> <td>PB</td> <td>Polished Brass</td> <td>LSP</td> <td>Light Silver</td> <td>CPF*</td> <td>Custom Paint Finish</td> </tr> <tr> <td>PSS</td> <td>Polished Stainless Steel</td> <td>PGP</td> <td>Pale Gold</td> <td>CMF*</td> <td>Custom Metal Finish</td> </tr> </table>	BA	Brushed Aluminum	ABP	Antique Brass Paint	SGB	Semi Gloss Black	BB	Brushed Brass	BBP	Brushed Brass Paint	SGW	Semi Gloss White	BSS	Brushed Stainless Steel	LBPS	Light Bronze Paint Smooth	PRM	Primer Only	PB	Polished Brass	LSP	Light Silver	CPF*	Custom Paint Finish	PSS	Polished Stainless Steel	PGP	Pale Gold	CMF*	Custom Metal Finish	<table border="0"> <tr> <td>MOD*</td> <td>Modification / Consult Factory</td> </tr> </table>	MOD*	Modification / Consult Factory
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MOD*	Modification / Consult Factory																																						

Describe Modification:

Notes

- *Ava

DIM VIA DMX SIGNAL
DIMMING DRIVER AND DMX COMPATIBLE DIMMING MODULE IS REMOTELY LOCATED

STEP13

6-LONG

Type:

Project:

Qty:

WIRING

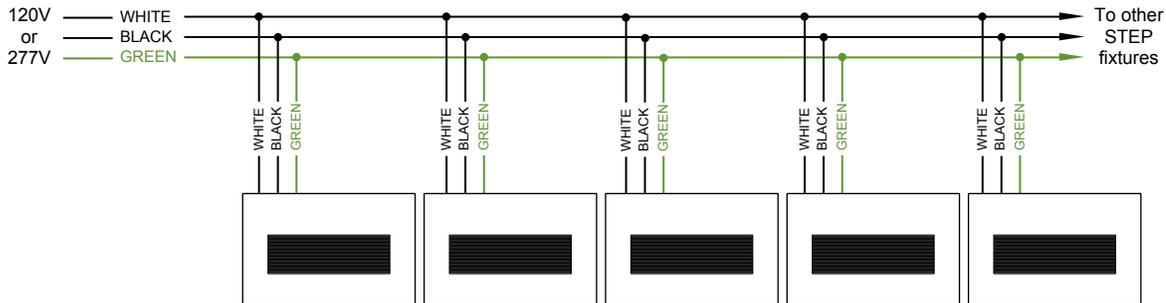
Read all instructions before installation. Do not make live connections!

NON-DIMMING INSTALLATIONS

Connect STEP WHITE wire to power NEUTRAL.

Connect STEP BLACK wire to power HOT.

Connect STEP GREEN wire to power GROUND.



DIMMING INSTALLATIONS

The integral dimming driver is designed to the 0-10V IEC dimming specification 60929 and is compatible with common 0-10V dimmers and dimming systems.

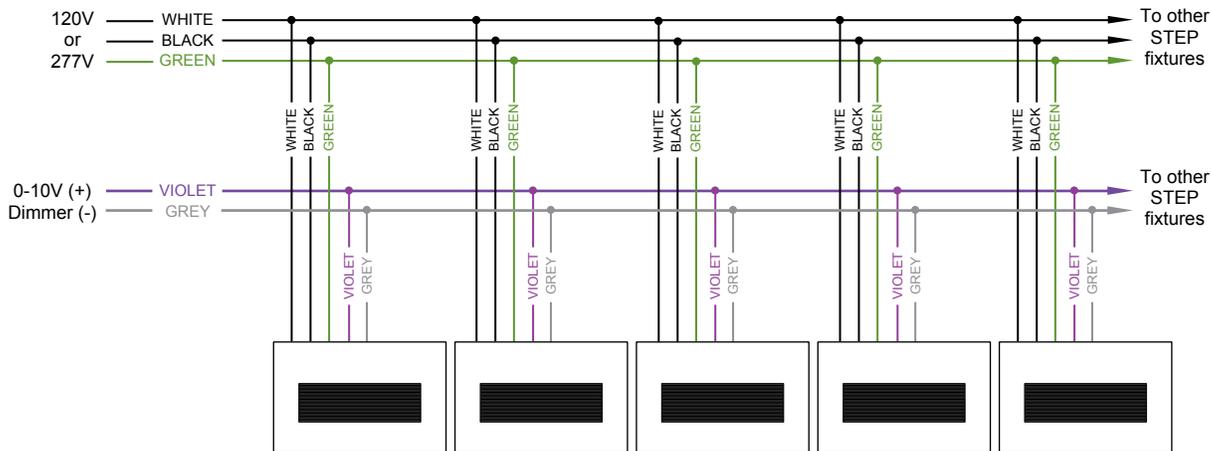
Do NOT connect line voltage to dimming input wires.

Connect STEP WHITE wire to power NEUTRAL.

Connect STEP BLACK wire to power HOT.

Connect STEP VIOLET wire to POSITIVE INPUT of Dimming Control.

Connect STEP GREY wire to NEGATIVE INPUT of Dimming Control.



G393-BLU

INFORMATION AND DESIGNS HEREON ARE PROPRIETARY AND CONFIDENTIAL. THEY MAY NOT BE USED OR REPRODUCED WITHOUT THE EXPRESSED

TYPE **L152**
AUERBACH · GLASOW

****dimming driver integral to fixtures****

12W, **LED ELECTRONIC** C.V. DRIVER,
120-227V AC INPUT/ 12VDC OUTPUT
EPTRONICS LD12W-12 (Secured to
Channel w/ two way tape)

COLE
LIGHTING SINCE 1911

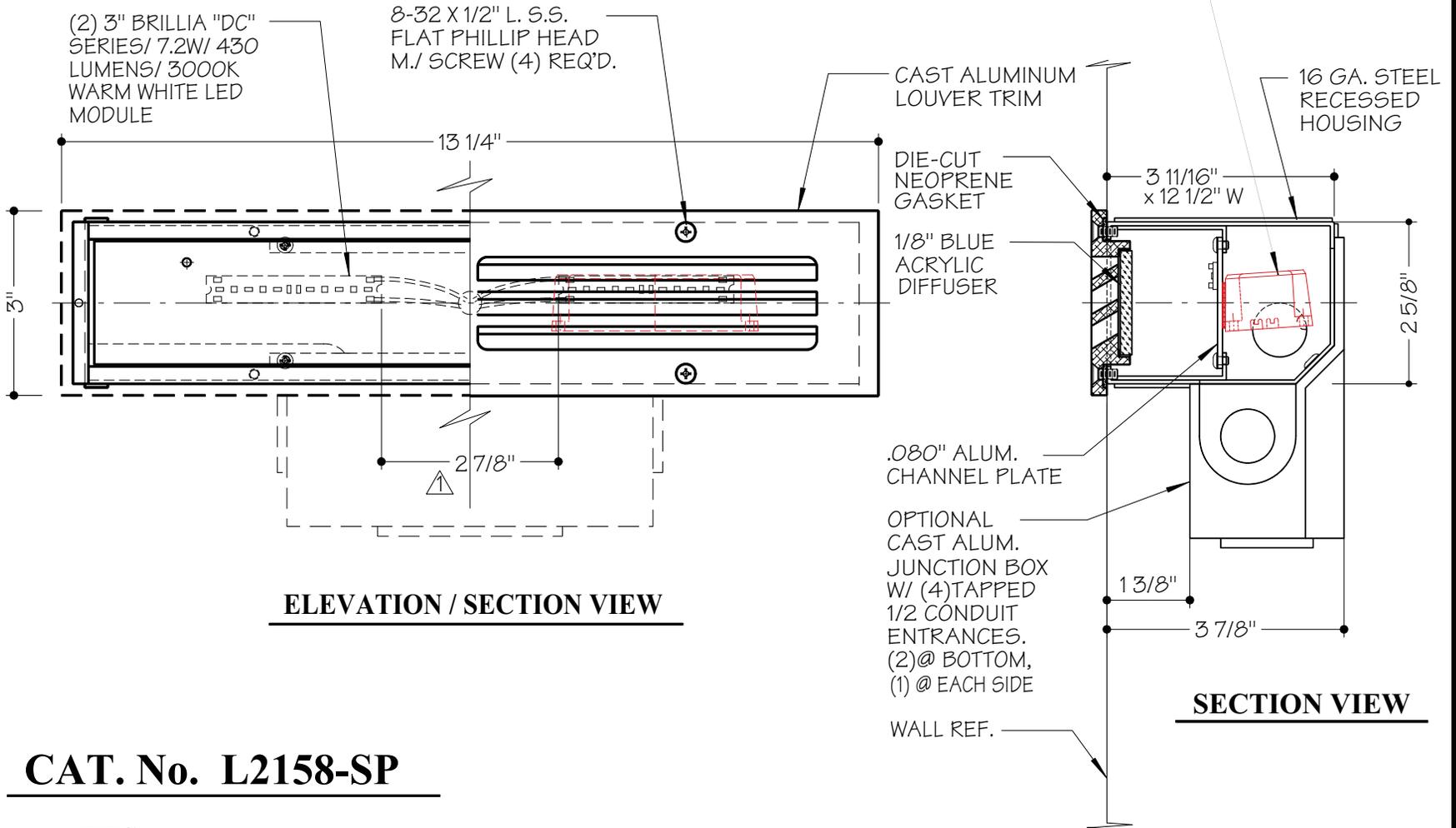
RECESSED STEPLITE 3000K

C.W. COLE & CO., INC. 2560 N. ROSEMEND BLVD., SOUTH EL MONTE, CA 91733-1593 • www.colelighting.com • (626) 443-2473 • FAX (626) 443-9253

REV. 6-12-12 CHG. TO DC BRILLIA LED SERIES.
120-277V 12W 12VDC LED DRIVER EPTRONICS
LED DRIVER-C.O.
6-20-12 ADDED LED SPACING DIM. -C.O.

DRAWN BY T. PHAN DATE 2-23-05
CHECKED BY D.W. DATE 2-23-05
SCALE 3/8" = 1"

DRAWING No **G393-BLU**



CAT. No. L2158-SP

NOTES:

- 1.) TRIM = CAST ALUMINUM WITH BLACK POLYESTER FINISH
- 2.) HOUSING = 16 GA. STEEL WITH WHITE POLYESTER FINISH
- 3.) ELECTRONIC BALLAST = SPECIFY 120V OR 277V
- 4.) JUNCTION BOX = CAST ALUM. FOR THRU-WIRING

OPTIONS

- J = JUNCTION BOX.
- W = WEATHERPROOF.

JOB NAME _____

Type _____

CATALOG NUMBER _____

Steplites

158 SERIES

SPECIFICATIONS

Construction

- Fixture housing is constructed from die-formed 16 gauge electro-galvanized steel finished with a white polyester coating
- Faceplate is cast aluminum with metallic aluminum polyester coating, gasketed and retained by stainless steel screws
- Diffuser is frosted tempered glass, set in silicone sealant
- Reflector is constructed of die-formed white aluminum
- Optional junction box is cast aluminum with polyester coating
- Incandescent models suitable for concrete pour/block wall construction only; LED and fluorescent models suitable for any wall construction
- All models cETLus listed for wet locations.

Electrical

- Fixture is wired with high performance LEDs, one compact fluorescent or one 40W A19 incandescent lamp
- Driver is standard universal voltage
- Ballast is standard 120V (277V optional) electronic
- Housing provided with 1/2" conduit knockout on each side suitable for 4 wire thru-wiring, 2 in and 2 out
- Optional junction box allows 8 wire thru-wiring, 4 in and 4 out. Provided with two 1/2" tapped conduit entrances in the bottom and one 1/2" tapped conduit entrance in each side.

Mounting

Housing has flange with holes for mounting.

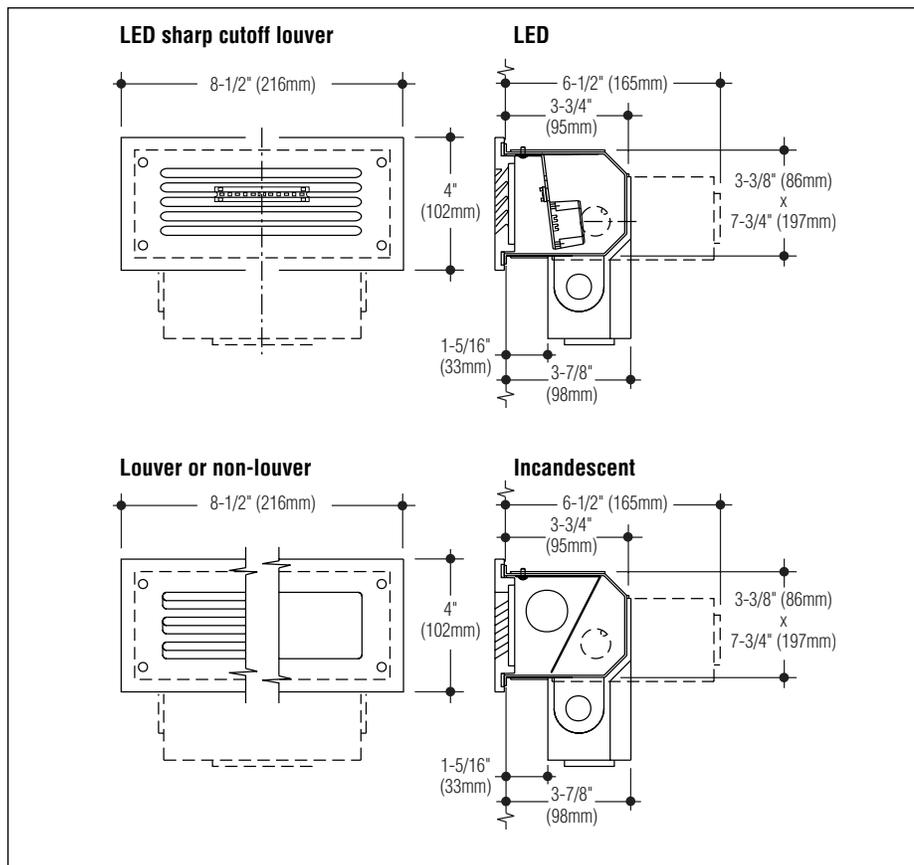
How to Specify

1. Select catalog number with desired features.
2. Add suffixes for options required to meet job conditions



C.W. Cole & Company, Inc.
2560 N. Rosemead Boulevard
South El Monte, CA 91733-1593

Tel. (626) 443-2473
Fax (626) 443-9253
info@colelighting.com
www.colelighting.com



Catalog Numbers

Lamp

- LED 1.5W, (126 lm @ 3000°K)
- LED 3.6W, (215 lm @ 3000°K)
- LED 7.2W, (430 lm @ 3000°K)
- One 7W or 9W (2G7 base) compact fluorescent
- One 40W T10 medium base incandescent

Faceplate

Louver

- L158W
- L158W-HO
- L158W-HO-2
- F158W
- T158W

Non-Louver

- L158GW
- L158GW-HO
- L158GW-HO-2
- F158GW
- T158GW

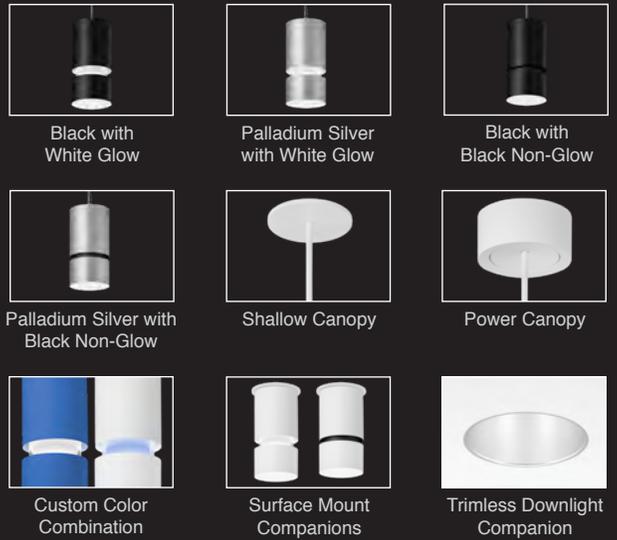
Options

- Junction box:** Bottom or back mounted junction box for feed-thru. Add suffix -J.
- Stainless steel faceplate:** 3/16" thick narrow louvered faceplate. Add suffix -N.
- Sharp cutoff louver:** Below horizontal illumination. Add suffix -SCL.
- Bronze faceplate:** Satin finish, clear coated. Add suffix -B.
- Stainless steel housing:** 16 gauge stainless steel recessed housing. Add suffix -SS.
- Voltage:** Fluorescent ballast. Add suffix -277. (LED universal voltage standard).
- Dimming:** Universal voltage 0-10V driver. Add suffix -DIM.

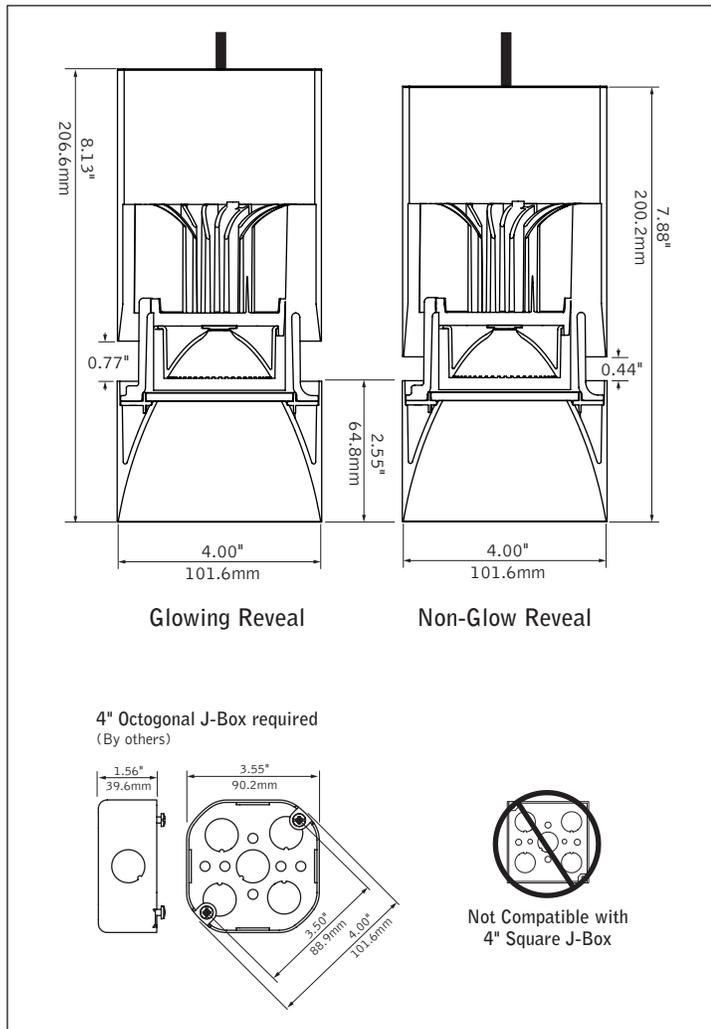
- Alternate faceplate color:** Black, white or custom color. Add suffix -BLK, -WHT, or -CC.
- Opal glass diffuser:** Tempered. Add suffix -OPL.
- Tamperproof screws:** Socket head faceplate screws. Add suffix -TP.
- LED colors:** 4000°K (146 lm), -HO (249 lm), -HO-2 (498 lm). Add suffix -4K.
Amber.* Add suffix -AMB.
Blue.* Add suffix -BLU.
*Not available in HO-2.

ID+ 3.5" Cylinder

LED PENDANT WITH DECORATIVE REVEAL



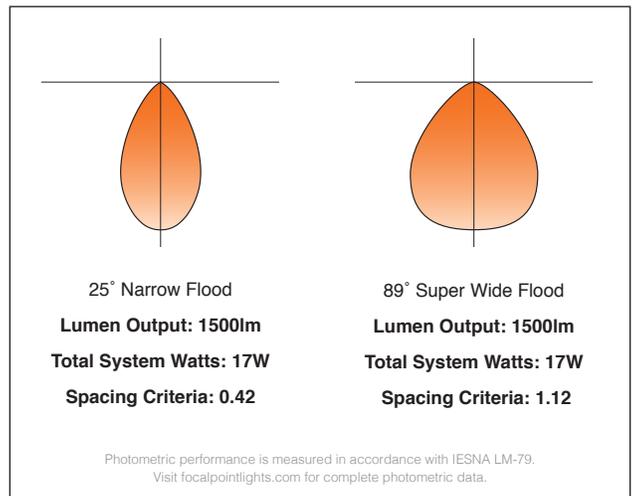
DIMENSIONAL DATA (continued on page 3)



FEATURES

- 3.5" cylinder pendant with decorative reveal.
- Decorative reveal available with or without glow.
- Custom color options for finish and glowing reveal.
- One-piece die-cast reflector with a knife edge for a modern aesthetic.
- 50° cut-off for brightness control and visual comfort.
- ChromaSure: Color consistency resulting in a 2-step MacAdam ellipse across the entire ID+ product line.

PERFORMANCE



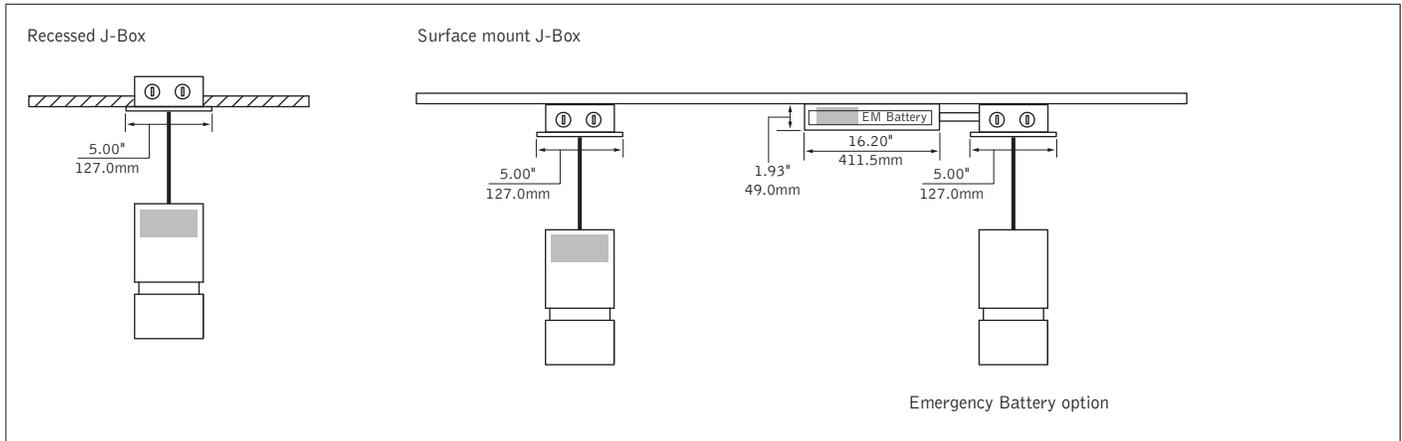
ID+ 3.5" Cylinder

LED PENDANT WITH DECORATIVE REVEAL

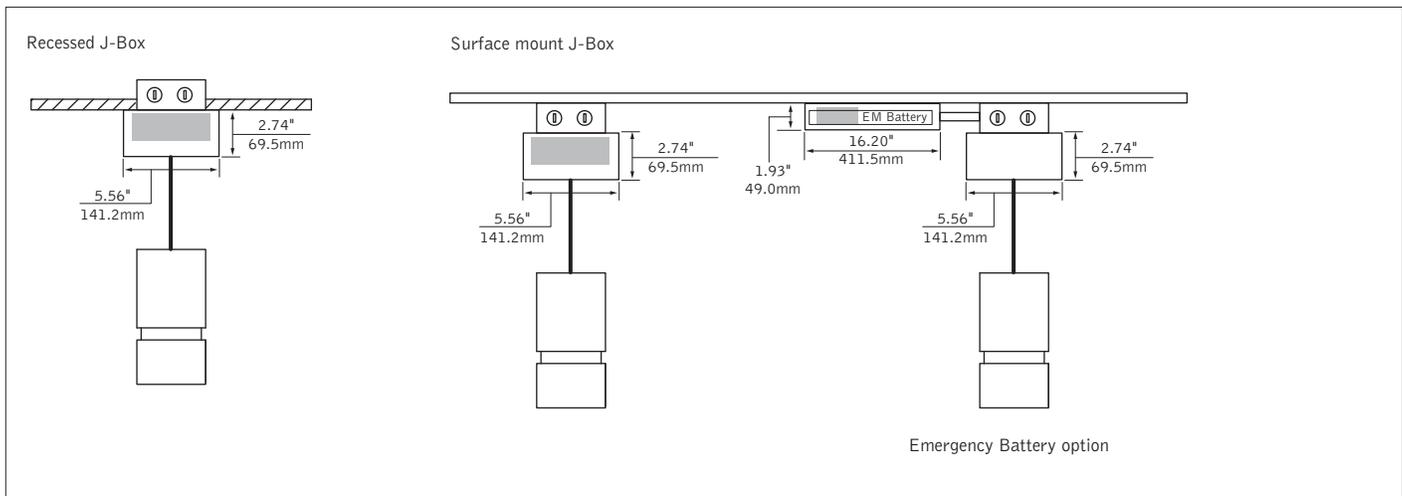
DIMENSIONAL DATA CONTINUED

SC - Shallow Canopy, Integral Driver

 Indicates Driver Location

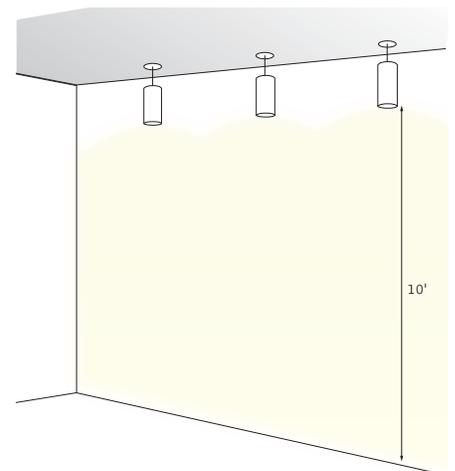


PC - Power Canopy



NON-SCALLOPING SUPER WIDE FLOOD DESIGN GUIDE - 1500 LUMEN EXAMPLE

Distance from bottom of fixture	Footcandles																	
	Fixtures 3' from Wall			Fixtures 3.5' from Wall			Fixtures 4' from Wall											
	3' OC	3.5' OC	4' OC	3' OC	3.5' OC	4' OC	3' OC	3.5' OC	4' OC	3' OC	3.5' OC	4' OC						
1'-0"	3"	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		
	6"	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2		
	9"	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3		
	12"	4	4	4	3	3	3	3	3	2	3	3	3	2	2	2		
2'	9	9	9	8	8	8	7	7	7	6	6	6	5	5	5	5	4	5
3'	17	17	17	15	15	14	13	13	13	11	11	11	10	10	10	8	8	8
4'	22	22	22	19	18	18	18	18	19	15	15	15	14	14	14	12	12	12
5'	21	21	21	18	18	18	19	19	18	16	16	16	17	17	17	14	14	14
6'	19	19	19	16	16	16	18	18	18	16	16	15	17	17	17	15	14	14
7'	16	16	16	14	14	14	17	17	16	14	14	14	16	16	16	14	14	13
8'	14	14	14	12	12	12	15	15	15	13	12	12	15	15	15	13	12	12
9'	12	12	12	10	10	10	13	13	13	11	11	10	13	13	13	11	11	11
10'	10	10	10	9	9	9	11	11	11	9	9	9	11	11	11	10	9	9



ID+ 3.5" Cylinder

LED PENDANT WITH DECORATIVE REVEAL

3.5" CYLINDER LUMEN MULTIPLIER TABLE

Color Temperature & CRI

Trim Type	Optic	Color Temperature	Multiplier
Round [RD]	ALL	2700K, 80+ CRI [27K]	0.93
		2700K, 90+ CRI [927K]	0.76
		3000K, 80+ CRI [30K]	1.00
		3000K, 90+ CRI [930K]	0.81
		3500K, 80+ CRI [35K]	1.00
		3500K, 90+ CRI [935K]	0.86
		4000K, 80+ CRI [40K]	1.00
		4000K, 90+ CRI [940K]	0.86

Optic

Trim Type	Optic	Distribution	Multiplier
Round [RD]	Tall Cone, 50° cut-off [DNT]	Narrow Flood (25°) [NFL]	1.00
		Flood 1 (38°) [FL1]	
		Flood 2 (46°) [FL2]	
		Wide Flood (52°) [WFL]	
	Tall Cone, 50° cut-off with Solite Lens [DNLS]	Narrow Flood (25°) [NFL]	0.90
	Super Short Cone, 80° cut-off [DSS]	Super Wide Flood (89°) [SWFL]	1.00

Distribution

Trim Type	Optic	Distribtuon	Multiplier
Round [RD]	Tall Cone, 50° cut-off [DNT]	Narrow Flood (25°) [NFL]	1.00
		Flood 1 (38°) [FL1]	0.87
		Flood 2 (46°) [FL2]	0.85
		Wide Flood (52°) [WFL]	0.81
		Tall Cone, 50° cut-off with Solite Lens [DNLS]	Narrow Flood (25°) [NFL]
	Super Short Cone, 80° cut-off [DSS]	Super Wide Flood (89°) [SWFL]	0.84

Multiplier tables are provided to aid with estimation of lumen levels across options. Apply multipliers against ordered Lumen Output to estimate Delivered Lumens. Refer to IES files for most accurate photometric information.

How To Use Lumen Multipliers

Formula: (Lumen Output Value) x (Color Temperature & CRI) x (Optic) x (Distribution)

Example: FLCY3-RD-1000L-935K-DNT-FL1

(1000) x (0.86) x (1.00) x (0.87) ≈ 748 lm (estimated delivered lumens)

ADVANCED HIGH CEILING

Atria 6 Series - Standard



6-inch aperture high lumen cylinder with lumen output 3470 – 9250lm. Additional features include outdoor/natorium rating, and ColorFlip™ tunable white.

- Outdoor/Natorium Rating

(Please refer to Outdoor/Natorium Version spec sheet)

Special coating, sealant, and wiring is applied for long term operation in harsh environments.

- ColorFlip™ (Please refer to Tunable White Version spec sheet)

Utilize latest flip chip technology for optimum efficacy, delivering consistent high lumen output with 105LPW at CRI85+ when color tuning from 2700K to 6500K. Compatible to all 0-10V and DMX dimming controls.

****dimming driver integral to fixtures****

Quantity	Type
Project	Note

Electrical System

- 3895lm (40W)
- 6180lm (60W)
- 7845lm (80W)
- 9250lm (100W)
- Power Input: Universal (120-277V)
- Operating Temperature: -13°F~112°F
- Surge Protection: 4KV
- Remote Emergency Pack: Bodine BSL20LV

LED Technology

- 2700K, 3000K, 3500K, 4000K
- 85 CRI, 93 CRI
- Beam Angle: 40°, 60°, 100° (with diffuser)
- Glowing Ring Option
- Rated Life > 60,000 hours (L70)

Advanced Dimming

(Proprietary VX Driver is incorporated to all dimming options for video flicker-free lighting)

- **Standard 0-10V:** dims to 10%
- **Superior 0-10V:** dim to less than 1 %
- **DMX:** high resolution 4,096 steps dims to <0.1%
- **TRIAC:** Line-voltage phase control, dims to less than 1% **(120V only)**
- **3-wire:** LUTRON Hi Lume 3-wire, dims to 1% **(UNV only)**
- **ECOsistem:** LUTRON Hi Lume ECOsistem, dims to 1 % **(UNV only)**

Housing

- Diameter: 6.4" (164mm)
- Height: 15" (381mm)
- Material: Aluminum
- Weight: 19.8 lbs

Mounting

- Surface Mount
- Stem 2ft or 4ft; 45° Swivel Canopy Included
- Adjustable Aircraft Cable 10ft
- Wall Mount (STV ONLY)
- Yoke Mount

Warranty

- 5 years limited warranty.

Listing

- ETL Listed
- FCC
- CE



Atria 6 Series - Standard



How To Specify:

Ordering Example:AS6-100-408-UNV-DMX-40-STD-BLK-SUM

4-5 weeks lead time on over 75% of specifications.

Model	Wattage	CCT / CRI	Voltage	Dimming
AS6				
AS6 Atria 6	40 40W 60 60W 80 80W 100 100W	278 2700K / CRI85 308 3000K / CRI85 358 3500K / CRI85 408 4000K / CRI85 279 2700K / CRI93 309 3000K / CRI93 359 3500K / CRI93	UNV 120-277V	STV Standard 0-10V <10% SPV Superior 0-10V <1% DMX DMX <0.1% (XLR Sockets) DMX(RJ45) DMX <0.1% (RJ45 Sockets) TRC TRIAC <1% (120V only) ECO LUTRON ECOsystem <1% (UNV only) 3WIR LUTRON 3-wire <1% (UNV only)

Beam Angle	Rim Finish	Finish	Mounting	Accessories
40 40° 60 60° WD* 100° (with diffuser)	 STD Without Ring  GLR Glowing Ring	BLK Black WHT White	SUM Surface Mount ST2 Stem 2ft ST4 Stem 4ft AD10 Adjustable Cable 10ft WLM Wall Mount (STV ONLY) YKM Yoke Mount	SPD ¹ Surge Protector EMP Remote Emergency Pack DF ² Diffuser

* Please factor in change in lumen output with diffuser (-20% with 100°; -12% with other degrees).

¹ Surge protector for up to 10KV. Applicable for unstable mains or facilities using high power machineries.
² Please factor in change in lumen output with diffuser (-20% with 100°; -12% with other degrees)

Atria 6 Series - Standard



Delivered Lumens*

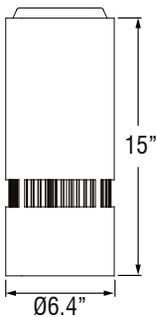
Wattage \ CCT	40W	60W	80W	100W
	Beam Angle: 40°			
4000K	3895 lm	6180 lm	7845 lm	9250 lm
3500K	3710 lm	5890 lm	7620 lm	9130 lm
3000K	3640 lm	5780 lm	7195 lm	8900 lm
2700K	3470 lm	5500 lm	6725 lm	8210 lm

*Tolerance ±8%

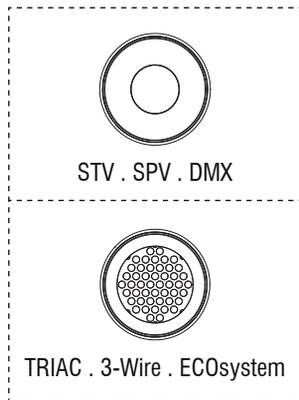
Current Consumption

Wattage \ Volt	120V	277V
40W	0.37A	0.16A
60W	0.55A	0.24A
80W	0.73A	0.32A
100W	0.92A	0.40A

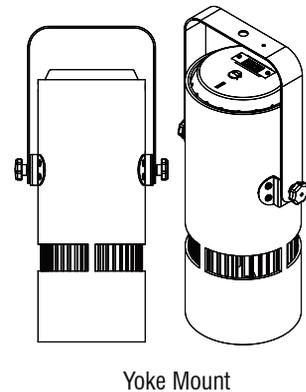
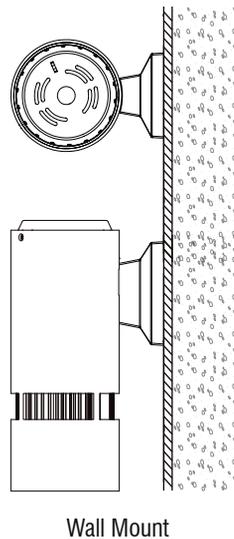
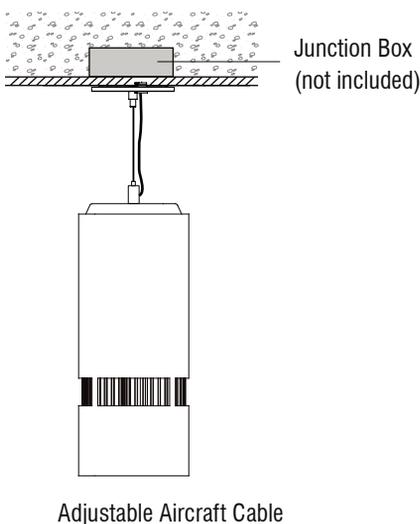
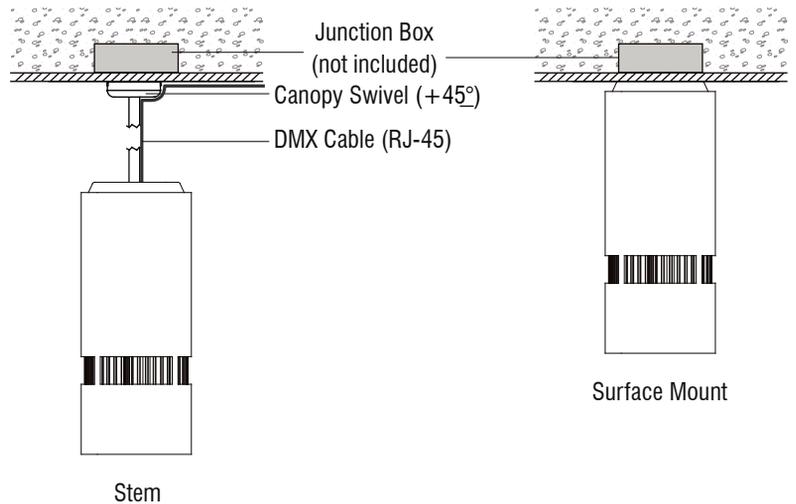
Dimensions



Appearance



Mounting Options



ADVANCED HIGH CEILING

Atria 6 Series - Standard



DMX Requirements

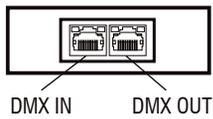
The AS6 LED fixture with DMX is a **ONE CHANNEL DMX unit**.

When placing order, please indicate DMX address. (The DMX address will be listed on the back of the fixture.)

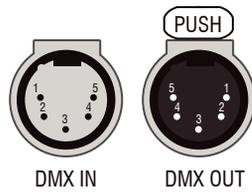
The LED fixture provide RJ45 Socket or XLR socket to connect. (DMX cable NOT included.)

The final fixture should be terminated by the use of DMX Terminator (by others).

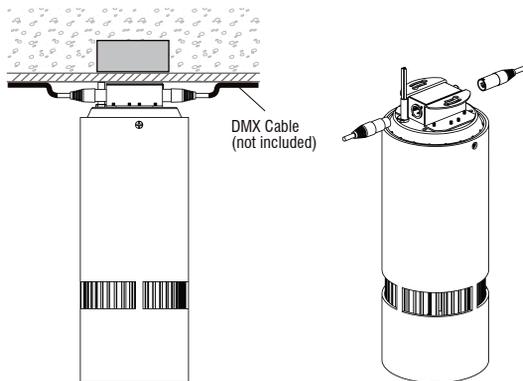
RJ45 Sockets



XLR Sockets



CONNECTION	RJ45 (CAT5e)	5-PIN XLR
Common	WHITE/BROWN(PIN7) & BROWN(PIN 8)	PIN 1
Signal -	ORANGE(PIN 2)	PIN 2
Signal +	WHITE/ORANGE(PIN 1)	PIN 3
Spare	-	PIN 4
Spare	-	PIN 5



Compatible TRIAC Dimmer List

LUTRON PART NO

RRD-6NA-	RRT-G5NEW-	RRT-GH	HQRD-10ND-	HQRT-GH	HQRD-HN	PD-10NXD-
RRD-6ND	RRT-G25LW-	HQRD-6NA-	MRF2-6ND-120-	HQRT-G25LW-	GT-250M-	PD-5NE-
RRD-10ND-	RRD-HN	HQRD-6ND-	MRF2S-6ND-120-	HQRT-G5NEW-	GTJ-250M-	

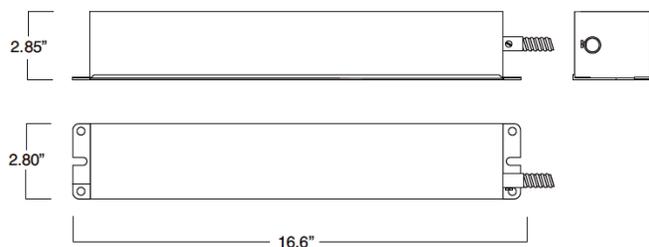
Atria 6 Series - Standard



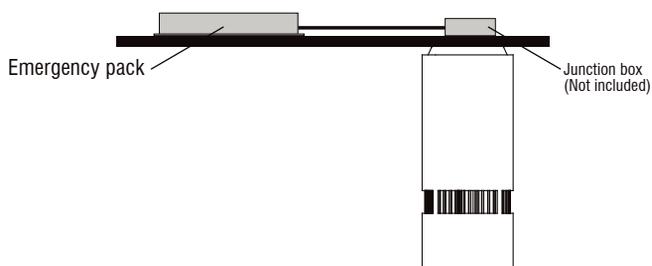
Emergency Pack Lumen Output Table

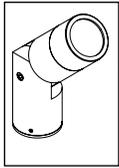
CCT	2700K	3000K	4000K	5000K
Lumen	1640 lm	1760 lm	1890 lm	1950 lm

Remote Emergency Pack



Mounting with standard ceiling recessed Junction BOX





ArtiStar™



Remote Transformer



TYPE L302
AUERBACH · GLASOW

ARTISTAR™

PROJECT:	
TYPE:	
CATALOG NUMBER:	
SOURCE:	
NOTES:	

CATALOG NUMBER LOGIC



Example **B** - **AR** - **LED** - **RM** - **e66** - **NSP** - **A7** - **MAC** - **12** - **11** - **B** - **6** - **WM**

Material
Blank - Aluminum **B** - Brass **S** - Stainless Steel

Series
AR - ArtiStar™

Source
LED - 'e' Technology with Integral Dimming Driver (See Specifications for Dimming)
Designed for use with remote 12VAC BKSSL® transformers. Requires magnetic Low Voltage dimmer

Housing
RM - Requires Remote Transformer

LED Type
e64 - 7WLED/2700K **e66** - 7WLED/4000K
e65 - 7WLED/3000K **e74** - 7WLED/Amber

Optics
NSP - Narrow Spot (Red Indicator) **MFL** - Medium Flood (Yellow Indicator)
SP - Spot (Green Indicator) **WFL** - Wide Flood (Blue Indicator)

Adjust-e-Lume® Output Intensity (Choose factory Setting)
A9 (Standard), **A8, A7, A6, A5, A4, A3, A2, A1**

Finish

Aluminum Finish

Powder Coat Color	Satin	Wrinkle
Bronze	BZP	BZW
Black	BLP	BLW
White (Gloss)	WHP	WHW
Aluminum	SAP	—
Verde	—	VER

Brass Finish

Machined	MAC
Polished	POL
Mitique™	MIT

Stainless Finish

Machined	MAC
Polished	POL
Brushed	BRU <small>Interior use only.</small>

Premium

ABP Antique Brass Powder	CMG Cascade Mountain Granite	RMG Rocky Mountain Granite
AMG Aleutian Mountain Granite	CRI Cracked Ice	SDS Sonoran Desert Sandstone
AQW Antique White	CRM Cream	SMG Sierra Mountain Granite
BCM Black Chrome	HUG Hunter Green	TXF Textured Forest
BGE Beige	MDS Mojave Desert Sandstone	WCP Weathered Copper
BPP Brown Patina Powder	NBP Natural Brass Powder	WIR Weathered Iron
CAP Clear Anodized Powder	OCP Old Copper	<small>Also available in RAL Finishes See submittal SUB-1439-00</small>

Lens Type
12 - Soft Focus Lens **13** - Rectilinear Lens

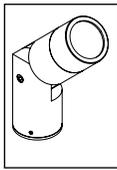
Shielding
11 - Honeycomb Baffle

Cap Style
A - 45° **B** - 90° **C** - Flush **D** - 45° less Weep Hole (Interior Use Only) **E** - 90° less Weep Hole (Interior Use Only) **E** - 90° with Flush Lens

Base Height
3 - 3" with Anchor Base **6** - 6" with Anchor Base **12** - 6" with Anchor Base **18** - 18" with Anchor Base **24** - 24" with Anchor Base

Option
PP - Power Pipe™ option with 18" Stake **SF** - Stability Flange (For use with Power Pipe™) **WM** - Wall or ceiling Mount with 5" dia. canopy**
** Base height limited to 6" max. with brass and stainless steel fixtures

B-K LIGHTING	40429 Brickyard Drive • Madera, CA 93636 • USA 559.438.5800 • FAX 559.438.5900 www.bklighting.com • info@bklighting.com	SUBMITTAL DATE 10-23-18	DRAWING NUMBER SUB001107
	<small>THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION OF B-K LIGHTING, INC. AND ITS RECEIPT OR POSSESSION DOES NOT CONVEY ANY RIGHTS TO REPRODUCE, DISCLOSE ITS CONTENTS, OR TO MANUFACTURE, USE OR SELL ANYTHING IT MAY DESCRIBE. REPRODUCTION, DISCLOSURE OR USE WITHOUT SPECIFIC WRITTEN AUTHORIZATION OF B-K LIGHTING, INC. IS STRICTLY FORBIDDEN.</small>		



ArtiStar™

BKSSL
BRIDGE KIGHTING SOLID STATE LIGHTING

Remote Transformer



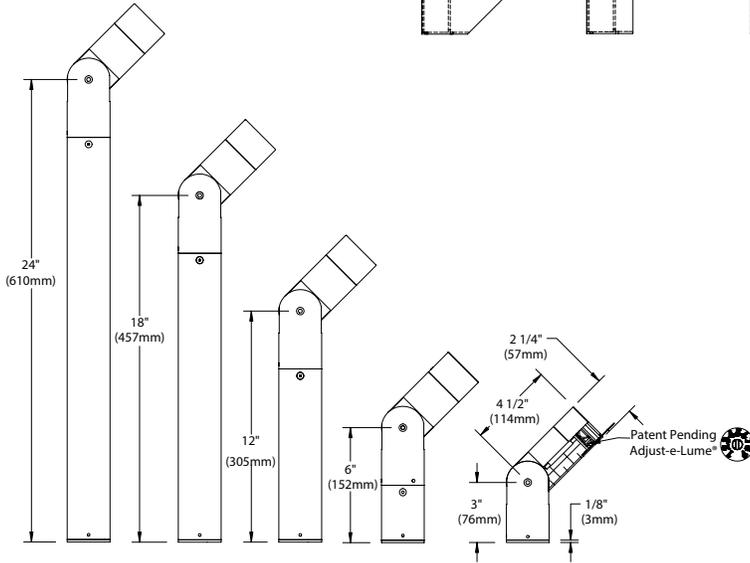
TYPE L302
AUERBACH·GLASOW

ARTISTAR™

PROJECT:

TYPE:

**ANCHOR BASE
STANDARD MOUNT**



"A/D" CAP

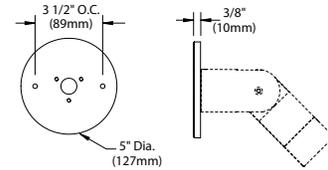
"B/E" CAP

"C" CAP

STANDARD BASE

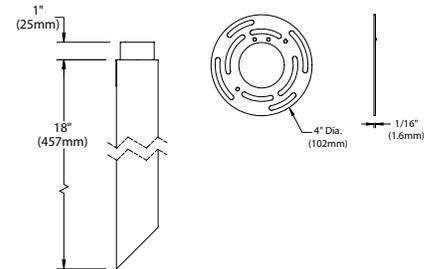


WALL MOUNT CANOPY



POWER PIPE

UNIVERSAL RING



All dimensions indicated on this submittal are nominal.
Contact Technical Sales if you require more stringent specifications.

SPECIFICATIONS

GreenSource Initiative™

Metal and packaging components are made from recycled materials. Manufactured using renewable solar energy, produced on site. Returnable to manufacturer at end of life to ensure cradle-to-cradle handling. Packaging contains no chlorofluorocarbons (CFC's). Use of this product may qualify for GreenSource efficacy and recycling rebate(s). Consult www.bklighting.com/greensource for program requirements.

Materials

Furnished in Copper-Free Aluminum (Type 6061-T6), Brass (Type 360) or Stainless Steel (Type 304).

Body

Fully machined from solid billet. Unibody design provides enclosed, water-proof wireway and integral heat sink for maximum component life. Integral knuckle for maximum mechanical strength. High temperature, silicone 'O' Ring provides water-tight seal.

Knuckle

'Aim and Lock' knuckle is comprised of two components. The first is integral to the body and features an interior, machined taper. The second is machined from solid billet and features a second, reverse angle taper. The resultant mechanical taper-lock allows a full 180° vertical adjustment without the use of serrated teeth, which inherently limit aiming. High temperature, silicone 'O' Ring provides water-tight seal and compressive resistance to maintain fixture position. Design withstands 73 lb. static load prior to movement to ensure decades of optical alignment. Biaxial source control with 360° horizontal rotation in addition to vertical adjustment.

Cap

Fully machined. Accommodates [1] lens or louver media. Choose from 45° cutoff ('A' or 'D'), 1" deep bezel with 90° cutoff ('B' or 'E'), flush lens ('C') cap styles, or 1" deep cutoff with flush mounted lens ('F'). Accommodates up to (2) lens or louver media. 'A' and 'B' caps include weep-hole for water and debris drainage. 'D' and 'E' caps exclude weep-hole and are for interior use only.

Lens

Shock resistant, tempered, glass lens is factory adhered to fixture cap and provides hermetically sealed optical compartment. Specify soft focus (#12) or rectilinear (#13) lens.

BKSSL®

Integrated solid state system with 'e' technology is scalable for field upgrade. Modular design with electrical quick disconnects permit field maintenance. High power, forward throw source complies with ANSI C78.377 binning requirements. Exceeds ENERGY STAR® lumen maintenance requirements. LM-80 certified components.

Integral, constant current driver. 12VAC/VDC input. 50/60Hz. Proprietary input control scheme achieves power factor correction and eliminates inrush current. Output, over-voltage, open-circuit, and short circuit protected. Inrush current limited to <250mA (non-dimming). Conforms to Safety Std. C22.2 No. 250.13-12.

Dimming

Line voltage dimmable via magnetic low voltage dimmer. For use with low voltage dimmer with dedicated neutral conductor. For purposes of dimming: Remote magnetic transformer with BKSSL® Power of 'e' technology loads should be loaded to 25% of the transformer VA (watts) rated value.

Optics

Interchangeable OPTIKIT™ modules permit field changes to optical distribution. Color-coded for easy reference: Narrow Spot (NSP) = Red. Spot (SP) = Green. Medium Flood (MFL) = Yellow. Wide Flood (WFL) = Blue.

Adjust-e-Lume® (Pat. Pending)

Integral electronics allows dynamic lumen response at the individual fixture. Indexed (100% to 25% nom.) lumen output. Maintains output at desired level or may be changed as conditions require. Specify factory preset output intensity.

Installation

Available for installation in three distinct mounting conditions:

Anchor Base (Standard)

Machined anchor base with 7/8" dia. slip conduit hole and [3] 3/16" dia. anchor bolt holes (hardware by others).

Power Pipe™ (Optional)

Provides a clean transition from wiring system to fixture. Schedule 80, 18" PVC housing for direct burial into soil or concrete. Machined 2-1/4" dia. cap for fixture mounting. Stainless steel hardware. Optional 6" diameter, molded stability flange, which simplifies installation and projects into substrate to reinforce housing stability.

Wall Mount Canopy (Optional)

Optional 5" dia. machined canopy permits mounting to junction box (gasket by others). 6" maximum base height for canopy-mounted brass or stainless steel fixture.

Remote Transformer

For use with 12VAC BKSSL® remote transformer or magnetic transformers only. B-K Lighting cannot guarantee performance with third party manufacturers' transformers.

Wiring

XLPE, 18GA, 150C, 600V, rated and certified to UL3321.

Hardware

Tamper-resistant, stainless steel hardware. Knuckle vertical aiming screw is additionally black oxide treated for additional corrosion resistance.

Finish

StarGuard®, our exclusive RoHs compliant, 15 stage chromate-free process cleans and conversion coats aluminum components prior to application of Class 'A' TGIC polyester powder coating. Brass components are available in powder coat or handcrafted metal finish. Stainless steel components are available in handcrafted metal finish. (Brushed finish for interior use only).

Warranty

5 year limited warranty.

Certification and Listing

ITL tested to IESNA LM-79. UL Listed. Certified to CAN/CSA/ANSI Standards. RoHs compliant. Suitable for indoor or outdoor use. Suitable for use in wet locations. Suitable for installation within 4' of the ground. IP66 Rated. Made in USA.



*Teflon is a registered trademark of DuPont Corporation.
*Energy Star is a registered trademark of the United States Environmental Protection Agency.

B-K LIGHTING

40429 Brickyard Drive • Madera, CA 93636 • USA
559.438.5800 • FAX 559.438.5900
www.bklighting.com • info@bklighting.com

SUBMITTAL DATE
10-23-18

DRAWING NUMBER
SUB001107



S2259

80PAR38/HAL /XEN /FL /120V
80 watt; Halogen; PAR38; Clear; 1500 Average rated Hours;
1600 Lumens; Medium Skirted base; 120 volts

Features

- Energy Saving Halogen
- Bright, Crisp light
- Indoor / Outdoor
- Uniform light output



S2259

Item Number	UPC	Watts	Voltage	Lamp Shape	Base	ANSI Base	Lamp Code
S2259	045923022593	80	120	PAR38	Medium Skirted	E26SK	80PAR38/HAL /XEN /FL /120V

Finish	MOL In Inches	MOD In Inches	Filament	Initial Lumens	Kelvin Temp	Color	Average Rated Hours
Clear	5-5/16"	4-3/4"	CC-8	1600	3050	Neutral White	1500

Pack	Package Type	Beam Spread Deg	CBCP	Dimmable/Non-Dimmable	CEC Status	RoHS Compliant
15	Box	30	2560	Dimmable	Lawful for sale in California	Yes



National Toll-Free:
800.43.SATCO
(800.437.2826)
www.satco.com

Distribution Centers:
New York, Florida, Texas,
Washington, California,
Puerto Rico

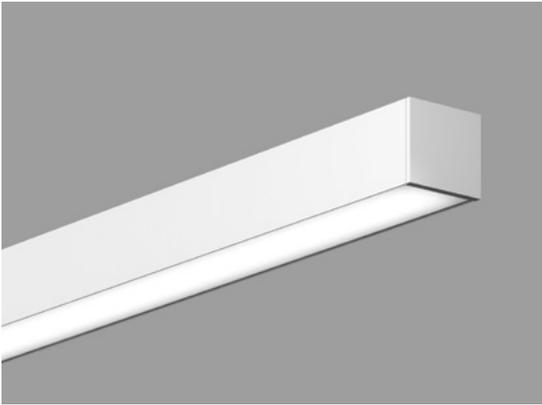
Corporate Offices:
110 Heartland Blvd.,
Brentwood, NY 11717
800.437.2826 631.243.2022
Fax 631.243.2027





VIA 4 LED

SURFACE



Shown with HLO optics

DESCRIPTION

Via 4 is the flexible linear LED luminaire system for pendant, surface and recessed or in-wall installation, whether as discrete luminaires, continuous runs or patterns. Via 4 features numerous high-efficiency optical configurations, including separately controlled indirect/direct, wall wash and asymmetric distributions, as well as a wide range of electrical, control and trim options. See separate spec sheets for patterns and other available mountings.

PROJECT: _____
 TYPE: _____
 NOTES: _____



up to 126 lm/w performance

ORDER GUIDE

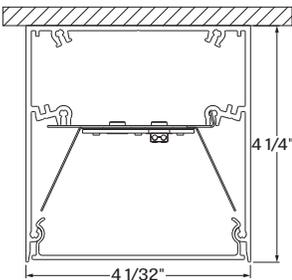
VIA4S	HLO	LED			
LUMINAIRE ID	OPTICS	LIGHT SOURCE	CRI	LUMEN PACKAGES	COLOR TEMP.
VIA4S - via 4" surface	HLO - High-Efficiency Lambertian Optic	LED - high performance LED	80 - 80CRI 90 - 90CRI	500 - min. low output 500lm/ft 750 - medium output 750lm/ft 1000 - high output 1000lm/ft 1200 - max. ultra high output 1200lm/ft #### - other required lm/ft	30 - 3000k 35 - 3500k 40 - 4000k

LUMINAIRE LENGTH	VOLTAGE	DRIVER	ELECTRICAL	MOUNTING	FINISH
Standard sections - 2', 3', 4', 5', 8' & 12' For all other specify length #FT - nominal length in feet #IN - length in inches Continuous Run - for luminaires over 12' Minimum Individual section 2'	120 - 120V 277 - 277V UNV* - 120V-277V 347 - 347V (not available with Lutron) * not available with MR16	D1 - 1% dimming 0-10V DA - Dali LTEA2W - Lutron 1% - 2 wires 120V LDE1 - Lutron 1% Eco Dim to Off LDE5 - Lutron 5% EcoSystem	1 - 1 circuit +EB - emergency battery (min 4' fixture, except Lutron) +EM - emergency light circuit +NL - night light circuit +COB/MR - COB/MR circuit +GTD### - generator transfer device, 120V or 277V	GRD - grid ceiling DRC - drywall ceiling	W - matte white AL - aluminum B - matte black CF# - custom finish specify RAL#

CONTROLS	LED DOWNLIGHT	COB CRI	COB LUMEN PACK.	COB COLOR TEMP.	COB DRIVER	OPTIONS
INDIVIDUAL CONTROLS OMS - Onboard Occupancy ODS - Onboard Daylight OCS - Onboard Occupancy & Daylight GROUPED CONTROLS LSC - Local system NSC - Network system	#COB20 - COB 20° #COB30 - COB 30° #COB40 - COB 40° #MR16 - MR16 LED Minimum individual section with downlight 4'	80 - 80CRI 90 - 90CRI 97 - 97CRI (consult factory)	600 - 600lm 1200 - 1200lm 1800 - 1800lm	30 - 3000k 35 - 3500k 40 - 4000k	D1 - 1% dimming 0-10V DA - Dali	FU - fuse CU - custom

See page 2 for ordering code detailed information

CROSS SECTION



VIA4S - surface

OPTICS



HLO - High-efficiency Lambertian Optic



VIA 4 LED

SURFACE

OPTICS

HIGH EFFICIENCY LAMBERTIAN OPTIC (HLO) - Matte white side reflectors combined with High-Efficiency Lambertian Optic (HLO) shielding of diffusing 0.075" thick acrylic with up to 88% transmission and good source obscuration. Luminaire brightness is controlled by the flux-to-shielding area ratio.

LIGHT SOURCE - LED

Custom linear array of mid-flux LED's are cartridge-mounted with quick-connect wiring to facilitate service and thermal management. Available in 3000K, 3500K and 4000K with a minimum 80 CRI and an option for 90 CRI with elevated R9 value. Color consistency maintained to within 3 SDCM. LEDs operated at reduced drive current to optimize efficacy and lumen maintenance.

All LEDs have been tested in accordance with IESNA LM-80-08 and the results have shown L80 lumen maintenance greater than 60,000 hours. Absolute product photometry is measured and presented in accordance with IESNA LM-79, unless otherwise indicated.

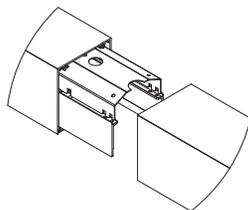
PERFORMANCE PER 4' AT 4000K

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
low output	4000K	16	2000	126
medium output	4000K	25	3000	121
high output	4000K	33.5	4000	119
ultra high output	4000K	40.5	4800	118

LUMINAIRE LENGTH

Via 4 is made up of standard 2, 3, 4, 5, 8 and 12 foot sections that may be joined together to create longer continuous run lengths. Exact run length must be noted in the product code. The minimum individual section available is 2 foot, and continuous run lengths can be ordered in 2 inch increments.

All individual sections are joined together onsite using the joiner kits provided. LumenWerx offers joiner kits that are extremely simple to work with in the field and result in a fixture that appears virtually seamless with no light leak at any connection.



joining system Via 4 direct

ELECTRICAL

Factory-set, adjustable output current LED driver with universal (120-277VAC) input. Dimmable from 100% to 1% with 0-10V dimming control. Rated life (90% survivorship) of 50,000 hours at 50°C max. ambient (and 70°C max. case) temperature. At maximum driver load: Efficiency>84%, PF>0.9, THD<20%. Other specifiable options include Lutron Hi-Lume 1% (specify 2-wire, or Ecosystem Dim-to-Off), Lutron 5-Series (5% Ecosystem), DMX (RDM compatible) and DALI protocol drivers. All of our standard 0-10V drivers are NEMA 410 compliant.

EMERGENCY

Factory installed long life high temperature recyclable Ni-Cad battery pack with test switch and charge indicator; minimum of 90 minutes operation, up to 1000 lumens per 4ft (25°C) emergency lighting output. Recharge time of 24 hours.

MOUNTING OPTIONS

Fixtures can be mounted directly to T-Bar, drywall and hard surface ceilings, hardware supplied by others. Long runs require a minimum of 6" distance from the vertical wall.

FINISH

Interior - 95%, reflective matte powder coated white paint

Exterior - matte white, matte black or aluminum powder coating.

Custom finishes are also available.

CONTROLS

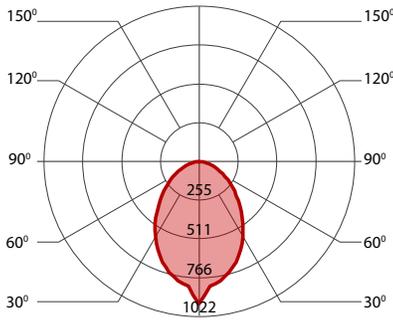
LumenWerx offers several options for integrating occupancy and daylight controls. Whether a sensors control its own fixture or is part of a group of fixtures, lights can be automatically controlled according to different energy saving strategies. With **individual Controls**, an on-board sensor controls the fixture in which it is installed. Depending on the length, more than one sensor may be necessary and may control the entire fixture, or just a section.

With **Grouped Controls**, on-board or remote sensor are part of a either a local or network sensor infrastructure. It's possible to scale the controls, from a switch to a fixture setup, to a room or a whole building Occupancy and or daylight harvesting.

VIA 4 LED

SURFACE

500 LUMEN AT 80CRI - LOW OUTPUT

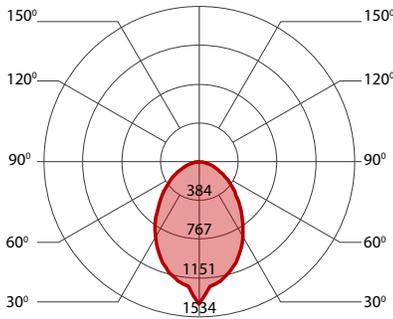


PERFORMANCE PER 4'

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
low output	3000K	16.5	2000	120
low output	3500K	16.5	2000	122
low output	4000K	16	2000	126



750 LUMEN AT 80CRI - MEDIUM OUTPUT

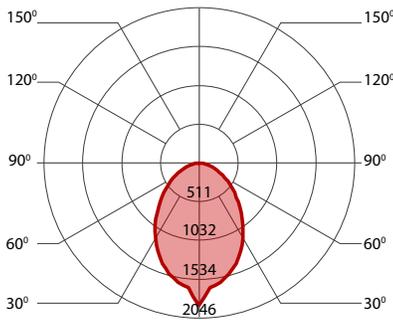


PERFORMANCE PER 4'

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
medium output	3000K	26.5	3000	114
medium output	3500K	25.5	3000	117
medium output	4000K	25	3000	121



1000 LUMEN AT 80CRI - HIGH OUTPUT

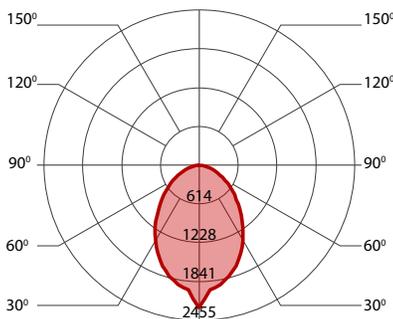


PERFORMANCE PER 4'

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
high output	3000K	35.5	4000	113
high output	3500K	34.5	4000	116
high output	4000K	33.5	4000	119



1200 LUMEN AT 80CRI - ULTRA HIGH OUTPUT



PERFORMANCE PER 4'

LED output	Color Temp	Watts	Nominal Delivered Lumens	Efficacy LPW
ultra high output	3000K	43	4800	112
ultra high output	3500K	42	4800	114
ultra high output	4000K	40.5	4800	118





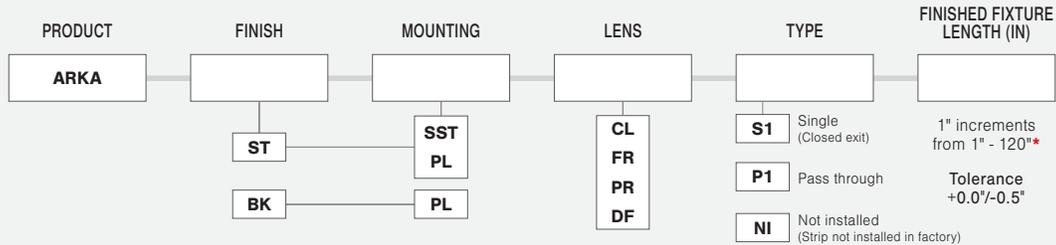
ARKA

EXTRUSIONS - ALUMINUM (iQA)



TYPE L375

AUERBACH · GLASOW



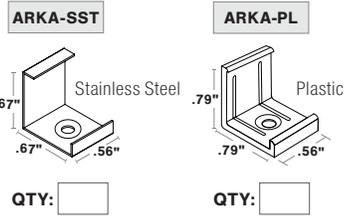
- NOTES:**
- * 10 ft extrusions only stocked in Satin
 - UL Listed when assembled with STRIP LEDs at Q-Tran
 - NRTL Listed for install in Storage Areas with Clothing, NEC Field 410.2 and 410.16 when assembled as a fixture, with 4.0 w/ft or less, at Q-Tran facility
 - Field modifications must comply with Q-Tran's installation methods otherwise warranty is null and void

FINISH

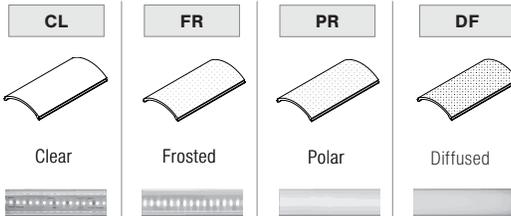


MOUNTING

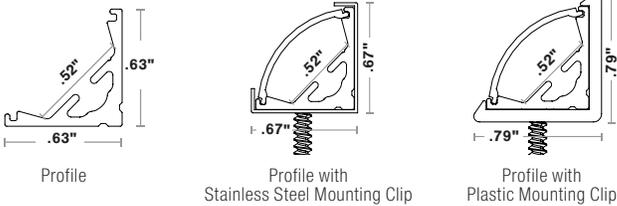
NOTE: 2 clips provided for 4' or less; 4 clips provided for greater than 4'



LENS with LED visibility

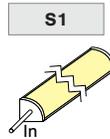


DIMENSIONS

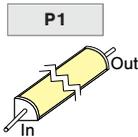


TYPE

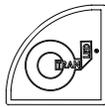
SINGLE (Input only)



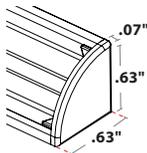
PASS THROUGH (Input/Output)



END CAPS



QTY:

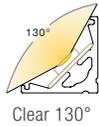


Endcap

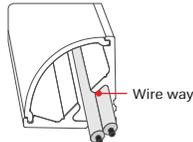
ORDER EXAMPLE



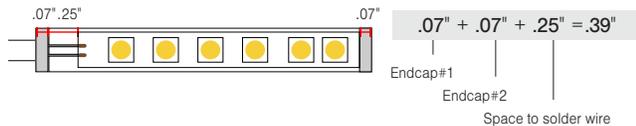
CUT OFF



WIRE WAY



LENGTH (IN)



PROJECT NAME	DATE	COMPANY	TYPE	NOTE

SW24/3.0

TYPE L375

AUERBACH·GLASOW



STRIP - STATIC WHITE

V/WATTS	RATED	CCT - LUMENS/CRI	² CONNECTOR/ WIRE IN	² CONNECTOR/ WIRE OUT	ILLUMINATED LENGTH (IN)
SW24/3.0 Voltage: 24 VDC Wattage: 3.0 W/Ft	DRY	20 - 2000K 230/94	¹BW BRL CLS	¹BW BRL CLS	1"-384" OR ²MATCH 1" increments Matches EXT length ordered
		24 - 2400K 245/94			
		27 - 2700K 255/95			
		30 - 3000K 269/95			
		35 - 3500K 287/96			
		40 - 4000K 300/96			
	DMP	24 - 2400K ****	¹BW BRL	¹BW BRL CLS	1"-180" OR ²MATCH 1" increments Matches EXT length ordered
		27 - 2700K 244/99			
		30 - 3000K 252/98			
		35 - 3500K 249/95			
		40 - 4000K 270/96			
		³ENC			
24 - 2400K 227/95					
27 - 2700K 230/95					
30 - 3000K 242/95					
35 - 3500K 262/96					
40 - 4000K 275/96					

ENC RATED STRIP ARE NOT FIELD CUTTABLE

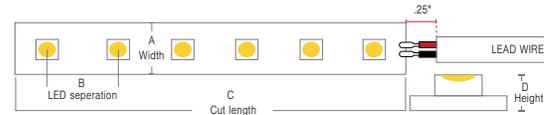
- NOTES:**
- Field modifications must comply with Q-Tran's installation methods otherwise warranty is null and void
 - All data has +/- 5% tolerance
 - 5 year warranty
 - NRTL Listed for install in Storage Areas with Clothing, NEC Field 410.2 and 410.16 when assembled as a fixture, at Q-Tran facility (Not applicable for encapsulation)
- Custom Bare Wire length up to 120" - request different length by writing it in inches next to "BW" in the order code box
 - Wire orientation for MATCH will be dictated by extrusion Feed In/Feed Out selection
 - If ordering an encapsulated extrusion, ENC (Encapsulated in Extrusion) must be chosen for your strip

TECHNICAL INFORMATION [L70 = 30000 HRS]

*Tested with SW24/3.0-DRY

CCT	Lumen/ft	CRI Ra	CRI R9	TM30 Rf	TM30 Rg
2000K	230	94	65	86	107
2400K	245	94	98	93	103
2700K	255	95	96	94	102
3000K	269	95	92	93	102
3500K	287	96	88	91	101
4000K	300	96	89	90	100

DIMENSIONS



Section (in)	DRY	DMP	WET
A	0.32"	0.32"	0.47"
B	0.16"	0.16"	0.16"
C	1.00"	1.00"	1.00"
D	0.06"	0.12"	0.21"

CONNECTOR/WIRE IN

¹BW	BRL	CLS
Bare Wire 24"	Male Barrel 6"	Not soldered DRY ONLY

CONNECTOR/WIRE OUT

¹BW	BRL	CLS
Bare Wire 24"	Female Barrel 6"	Not soldered

COMPATIBLE EXTRUSIONS

TORQ	SLIM	WIDE	VEGA	ROND	ARKA	TELA	VEVE	FLUR	LATO
<input checked="" type="checkbox"/> DRY									
<input checked="" type="checkbox"/> DMP									
<input checked="" type="checkbox"/> ENC									
<input checked="" type="checkbox"/> WET	<input checked="" type="checkbox"/> WET	<input checked="" type="checkbox"/> WET	<input type="checkbox"/> WET	<input type="checkbox"/> WET	<input checked="" type="checkbox"/> WET	<input checked="" type="checkbox"/> WET	<input checked="" type="checkbox"/> WET	<input checked="" type="checkbox"/> WET	<input checked="" type="checkbox"/> WET

PROJECT NAME	DATE	COMPANY	TYPE	NOTE



iQ-PH: PHASE CONTROLLED DRIVER

ORDERING GUIDE

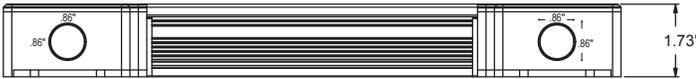
	Watts	Prim. V	Sec. V	Finishes	Option
iQ-PH	80	120	24	<input type="checkbox"/>	<input type="checkbox"/>

WH: White
BK: Black
C&P: Cord & Plug

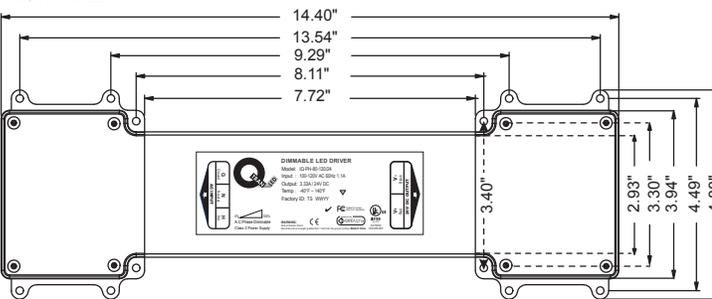
NOTE: White finish is standard



SIDE VIEW



FRONT VIEW

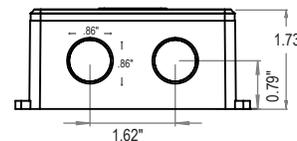


The **iQ-PH** is an ideal Constant Voltage electronic dimmable power supply for interior or exterior linear LED applications. It is capable of providing full-range 0-100% flicker-free dimming using either forward or reverse phase dimmers. Available in 80W at 24VDC and is UL Listed and Class II Rated. It is available in Satin/White for standard and all Black finishes.

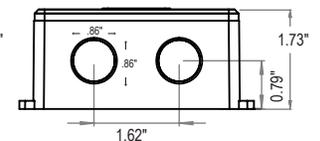
Driver Features

- Wide Dimmer compatibility-supports most phase type dimmers in the market (See chart next page)
- Forward Phase and Reverse Phase Dimmer control or on/off
- Integral wiring compartments for reduced installation costs
- Forward or Reverse Phase Dimming
- Completely potted design, no venting required
- Energy Star Compliant
- Active Power Factor Correction, PF>0.9
- Built-in protection:
SCP (Short Circuit Protection),
OTP (Over Temperature Protection),
OVP (Over Voltage Protection),
OCP (Over Current Protection)
- Operating temperature Range: -40 to +60°C (-40 to +140 °F)
- Constant Voltage

TOP VIEW



BOTTOM VIEW



NOTE: The LED drivers provide a constant voltage output for operating LED systems requiring 24V DC

20181024-V1

MODEL #	CHANNEL OUTPUT	OUTPUT				MAX OUTPUT POWER PER CHANNEL (W)	RATED OUTPUT POWER	
		VOUT (VDC)	Loading Current (w/dimmer) perChannel (A)		Loading Current (w/out) perChannel (A)			
			MIN	MAX	MIN			MAX
iQ-PH-80-120/24	1	24	1.16	3.30	0.17	3.30	79.2	80



SUPPORTED DIMMER LIST

90~120V AC ELV (Reverse phase) & Triac (Forward phase) Dimmer

Brand	Model	Dimmer Rating Power (max)	LED Flicker Free Test*
Lutron	DVCL-153PL (C/L)	600W	Pass
Lutron	TGCL-153P (C/L)	600W	Pass
Lutron	AB-600M-WH (Abella)	600W	Pass (##)
Lutron	D-600RH-DK (Rotary)	600W	Pass
Lutron	D-600R-WH (Rotary)	600W	Pass
Lutron	D-603PG-WH (Rotary)	600W	Pass
Lutron	GL-603PH-DK (GLYDER-3-way)	600W	Pass
Lutron	GL-600-WH (Glyder)	600W	Pass (##)
Lutron	MA-600GH-WH (Ecodim Digital with indicator leds)	500W	Pass (##)
Lutron	MIR-600THW-WH (RC Digital Fade Dimmer)	600W	Pass
Lutron	MS-VP600GHW-WH (Vacancy Sensor w/eco-dim Dimmer)	600W	Pass (##)
Lutron	S-600PH-WH (SKYLARK))	600W	Pass
Lutron	SELV-300PH-WH (SKYLARK-Single Pole)	300W	Pass
Lutron	TG-600PH-WH (Toggle)	600W	Pass
Lutron	TG-603PFH-WH (Toggle-eco-dim)	600W	Pass
Lutron	TT-300NLH-BL	600W	Pass
Cooper Wiring Devices	RI061-A (Rotary Dimmer w/ Non-Present)	600W	Pass
Cooper Wiring Devices	6001	600W	Pass
Cooper Wiring Devices	SLC03P (C/L)	600W	Pass
Cooper Wiring Devices	SI06P (non C/L)	600W	Pass
GE	DI61-271	600W	Pass
GE	DIB61-71	600W	Pass
GE	DIT61-71	600W	Pass
GE	DIT61-S71	600W	Pass
Legrand	V8051	600W	Pass

NOTE:

- ## -5-100% dimming range.
- Flicker tests were carried out to ensure full range, flicker-free dimming from min to full load.
- This is a representative list of dimmers only. Q-Tran makes no specific recommendation on product selection and there are no warranties of performance or compatibility implied. Refer to dimmer manufacturers for further information on LED compatibility. Lutron and their product brand names are registered brand names are registered trademarks.

WIRE LENGTH TABLE

		TOTAL LENGTH								
VDC	WATTS (W)	10 AWG (5.6mm ²)	12 AWG (3.3mm ²)	14 AWG (2.0mm ²)	16 AWG (1.3mm ²)	18 AWG (0.78mm ²)	20 AWG (0.50mm ²)	22 AWG (0.33mm ²)	24 AWG (0.20mm ²)	26 AWG (0.13mm ²)
24	17	940'	591'	372'	234'	147'	92'	58'	37'	23'
	25	629'	396'	249'	157'	98'	62'	39'	24'	15'
	40	384'	242'	152'	96'	60'	38'	24'	15'	9'
	80	180'	113'	71'	45'	28'	18'	11'	7'	4'

*Distances are based on a 5% Voltage drop max.

● This product must be installed in accordance with the applicable installation code by a person familiar with the construction and operation of the product and the hazards involved.

RoHS 2011/95/EU IP65 FC Tested To Comply With FCC Standards





SPECIFICATIONS

SPECIFICATIONS

	Min	Nom	Max
Input			
▪ Voltage (RMS)	100	120	130
▪ Frequency (Hz)	47	50/60	63
▪ Power Factor	0.9	----	----
Output			
▪ Line Regulation (%)	-10	----	10
▪ Load Regulation (%)	----	----	5
Environmental			
▪ Storage Temperature (°C)	-40	----	85
▪ Operating Temperature (°C)	-40	----	60
▪ Relative Humidity (%)	5	----	95
▪ MTBF (Hours @ 25°C (77°F), Full Load)	80,000	----	----

Protections

- Short Circuit Protection (**SCP**) : Hiccup-Mode, Auto-Recovery upon removal of short
- Over Voltage Protection (**OVP**) : 105% of Voltage (typ) Min
- Over Current Protection (**OCP**) : Hiccup-Mode
- Over Temperature Protection (**OTP**) : Shutdown with Auto-Recovery

Expected Lifetime

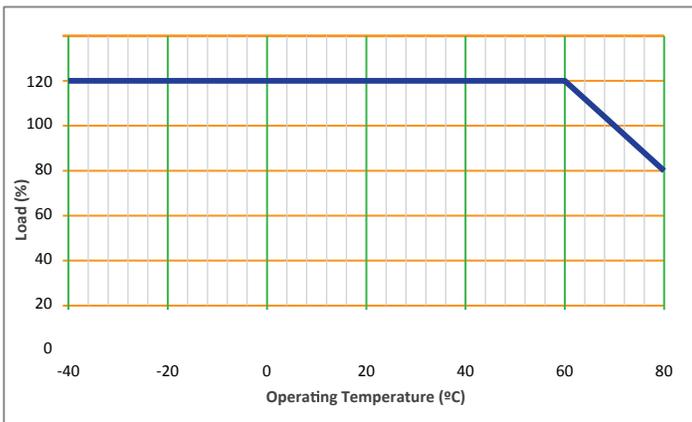
- Lifetime (Hours)

	Lifetime
65°C	50,000
75°C	30,000

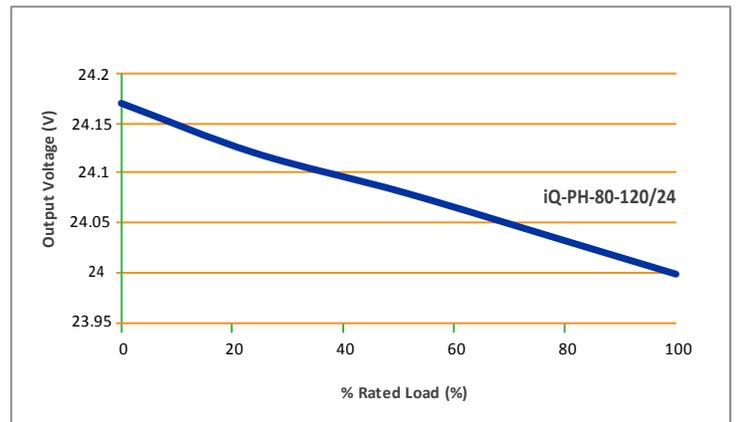
Compliance / Safety

- EMI / RFI : ISPR-22 Class B
: FCC part 15 Class B
: EN55015, EMC
- Safety : UL 1012, 1310 Class 2, 8750, 879
: CSA C22.2 NO. 107.1
: CE (IEC/EN61347-1, IEC/EN61347-2-13)
- IP Rating : 65

DERATING CURVE



OUTPUT VOLTAGE vs. LOAD



RECESSED TRACK (120V) • SPECIFICATIONS

GENERAL Recessed track shall be approved by the NEC for flush-mounting into ceiling or any flat surface. RecessedTrack shall allow fixtures to be easily focused, switched, dimmed, accessorized, and removed as desired. RecessedTrack shall have a twelve year warranty from date of shipment.

MECHANICAL RecessedTrack shall be constructed of .125 inch (3mm) extruded aluminum. RecessedTrack shall have the same overall dimensions and physical appearance for both one and two circuit models. RecessedTrack shall be available in Flanged and Flangeless configurations with high temperature white baked paint finish on all exposed surfaces.

Flanged RecessedTrack shall have an overall height of 1.63 inches (42mm) and overall width of 2.81 inches (72mm).

Flangeless RecessedTrack shall have an overall height of 1.63 inches (42mm) and overall width of 2.81 inches (72mm). FlangelessTrack available with 5/8 inch (16mm) height mounting fin to accommodate 5/8 inch sheet rock, or plaster.

RecessedTrack shall be available in nominal 4 foot (1.2m), 8 foot (2.4m), and 12 foot (3.7m) lengths and comes complete with all necessary hardware and components. RecessedTrack shall be field cuttable to any length with a single cut.

RecessedTrack system shall be available with End Feed, End Cap, Straight Mini-Joiner, Straight Joiner/Feeder, X Joiner/Feeder, L Joiner/Feeder, and T Joiner/Feeder as standard components.

RecessedTrack shall have integral side mounting channels to accept perforated mounting straps.

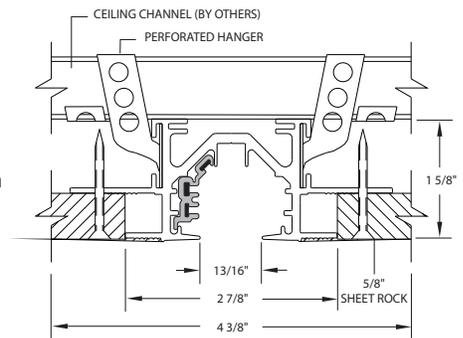
ELECTRICAL RecessedTrack and components shall be UL and CUL listed, CE Certified, and comply with the National Electric Code standards for LightingTrack. One and two circuit RecessedTrack shall be rated at 120/250 volt, 50/60 Hz, 2400 watts maximum each circuit. Each 20 amp/120/250 volt circuit shall be comprised of flat copper busbars and have a separate neutral busbar for each circuit. The neutral busbar shall be oversized to be comparable to #10 gauge 30 amp wire to reduce the possibility of overheating due to non-linear loads and harmonics. **Track shall have integral wiring channels for six (6) additional #12 THHN wires to create three (3) additional 20 amp/120/250 volt circuits, which can be dropped into any Joiner/Feeder, for a total track power capacity of 100 amps.** A separate grounding busbar shall be integral in all track lengths. All busbars shall be insulated to prevent contact with aluminum extrusion.

RecessedTrack shall have electrical feed capability through all Joiners/Feeders using either 1/2" or 3/4" U. S. trade size knock-outs (.875 inch diameter, 22mm or 1.125 inch, 29mm). Joiner/Feeders can be electrically field modified by removing the Lexan™ cover and rerouting internal pre-wired jumpers. All Joiner/Feeder covers shall be available in White GE fiber reinforced Lexan™.

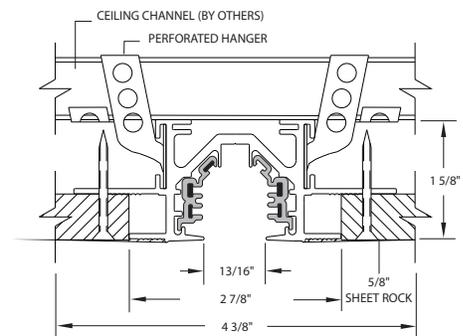
One and two circuit Recessed track lighting with separate neutral busbars shall have the ability to have each circuit separately dimmed as required when using standard voltage and low voltage fixtures with either magnetic or electronic transformers. RecessedTrack shall have the ability to be dimmed or switched in selected sections in addition to dimming or switching an entire recessed track configuration or recessed track run.

FIXTURE FITTING INTERFACE RecessedTrack shall accept only GE fiber reinforced Lexan™ fixture fittings which positively lock into recessed track and cannot be energized by integral switch until safety interlock handle is in the closed position. Safety interlock shall also prevent fixture fitting removal from recessed track unless the switch is in the "off" position. Upon insertion of fixture fitting into recessed track, grounding connection from fixture fitting to track shall be automatically completed before any electrical contact is made with busbars. When removing fixture fitting from track, the grounding connection shall automatically be disconnected last. The fixture fitting shall recess into the track, creating a minimal profile below the track.

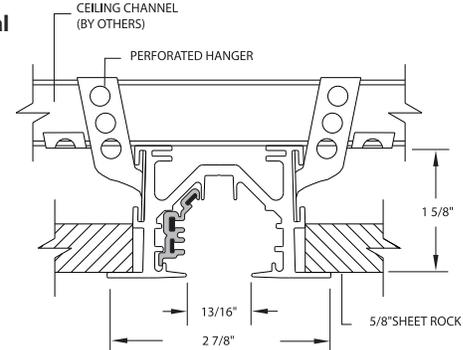
One Ckt 120V Recessed Flangeless Track



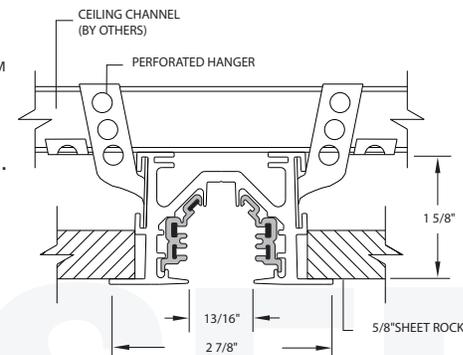
Two Ckt 120V Recessed Flangeless Track



One Ckt 120V Recessed Flanged Track



Two Ckt 120V Recessed Flanged Track

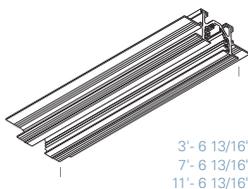


RECESSED FLANGELESS TRACK (120V) • COMPONENTS

Key Features / Applications

UL and CUL listed, CE Certified, Dry Location • IBEW union made at LSI plant in USA • Specification grade heavy duty .125 (3mm) extruded aluminum track • Flangeless Track available with 5/8 inch (16mm) height recessed flange to accommodate sheet rock or plaster • 4 foot (1.2m), 8 foot (2.4m), 12 foot (3.7m) field cuttable lengths complete with 14 inch perforated hanger straps for mounting hardware. • One circuit 20 amp or two circuit 40 amp capacity/120/250 volt • 100 amp total capacity when using integral wireways • Copper busbars equivalent to #12 AWG wire used as circuit and ground track conductors • Oversized copper busbars equivalent to #10 AWG wire used as neutral track conductors • Separate neutral track conductor used for each circuit track conductor • Separate copper grounding busbar used throughout track system • All Joiner/Feeders, Mini-Joiners and End Feeds are injection molded of GE fiber reinforced Lexan™ • All Joiner/Feeders are prewired and simply couple into track and can be easily field modified by changing internal jumper wires • Fixture fitting recesses into track for minimum profile • LSI recessed track can be mounted directly into any surface 5'-0" above finished floor.

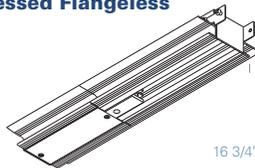
Track Sections-Recessed Flangeless



120V Recessed Flangeless Track Sections are open ended extrusions used to form track runs or configurations to be used in conjunction with an End Feed, End Cap, Straight Joiner/Feeder, Straight Mini Joiner, L Joiner/Feeder, T Joiner/Feeder, and X Joiner/Feeder. Track Section lengths are nominal 4 foot (1.2m), 8 foot (2.4m) and 12 foot (3.7m) and are supplied complete with galvanized perforated straps for mounting. Track is field cuttable.

Finish		Nominal Length		
		4 ft	8 ft	12 ft
White	One Ckt	81310	81320	81330
	Two Ckt	82310	82320	82330

Security/Worklight Track Recessed Flangeless



120V Recessed Flangeless Security/Worklight Track is a separately fed one circuit Track Section, suitable for most LSI track fixtures, that integrates into any LSI Track run or configuration at any location. Consult fixture cutsheet. LSI fixtures (add suffix EF) mechanically lock into Security/Worklight Track by means of special hardware and do not have on/off switches.

Finish	One Ckt	
	17" Joiner, End Feed, End Cap Section	
White	81351	

Top Feed Security/Worklight Joiner/Feeder Recessed Flangeless



120V Recessed Flangeless Security/Worklight Joiner/Feeder is used to mechanically and electrically couple two lengths of track in a straight line. It is top fed to energize the track through 1/2" conduits. Consult fixtures (add suffix EF) mechanically lock into Security/Worklight Track by means of special hardware and do not have on/off switches.

Finish		
Silver	Two Ckt	82054
Black	Two Ckt	82254
White	Two Ckt	82354

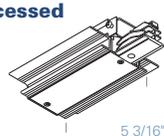
Unimount-Recessed Flangeless



120V Recessed Flangeless Unimount is a compact Recessed Track assembly which will accept most single LSI track fixtures up to 500 watts. Two piece construction allows for wiring and inspection.

Finish		
White	One Ckt	81361

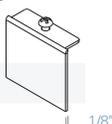
End Feed-Recessed Flangeless



120V Recessed Flangeless End Feed is used when track run is to be fed from the end of a run. The end feed is top fed directly from electrical cable to energize the track.

Finish		
White	One Ckt	81300
	Two Ckt	82300

End Cap-Recessed Flangeless

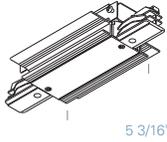


120V Recessed Flangeless End Cap is used for mechanically ending any straight run, individual Track Section, or open configuration Track Section. End cap is insulated on inside only.

Finish		
White	One & Two Ckt	80303

RECESSED FLANGELESS TRACK (120V) • COMPONENTS

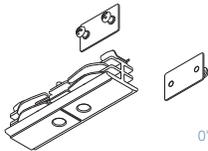
Straight Joiner/Feeder Recessed Flangeless



120V Recessed Flangeless Straight Joiner/Feeder is used to mechanically and electrically couple any two lengths of track in a straight line. The Straight Joiner/Feeder is top fed directly from cable to energize the track. Internal joiner wiring can be modified in the field.

Finish		
White	One Ckt Two Ckt	81304 82304

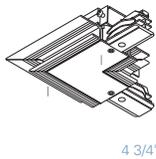
Straight Mini-Joiner Recessed Flangeless



120V Recessed Flangeless Straight Mini-Joiner is used to mechanically and electrically couple any two lengths of track in a straight line. Not for use as feeder. Alignment bars with screws included.

Finish		
White	One Ckt Two Ckt	81311 82311

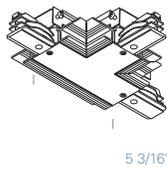
L Joiner/Feeder-Recessed Flangeless



120V Recessed Flangeless L Joiner/Feeder is used to mechanically and electrically couple any two lengths of track in an L right angle configuration. This L Joiner/Feeder can also be top fed directly from electrical cable to energize the track. Internal joiner wiring can be modified in the field.

Finish		
White	One Ckt Two Ckt	81305 82305

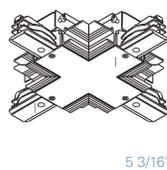
T Joiner/Feeder-Recessed Flangeless



120V Recessed Flangeless T Joiner/Feeder is used to mechanically and electrically couple any three lengths of track in a T configuration. This T Joiner/Feeder can also be top fed directly from electrical cable to energize the track. Internal Joiner wiring can be field modified. Note that in the one circuit version, a right or a left T must be ordered and must be used directly opposite each other when used in a configuration so that busbar continuity is maintained. For two circuit track, a left and right T is not necessary.

Finish		Left Joiner	Right Joiner
White	One Ckt Two Ckt	81306 82308	81307 82308

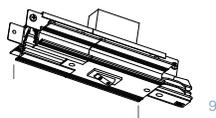
X Joiner/Feeder-Recessed Flangeless



120V Recessed Flangeless X Joiner/Feeder is used to mechanically and electrically couple any four lengths of track in an X configuration. This X Joiner/Feeder can also be top fed directly from electrical cable to energize the track. Internal joiner wiring can be modified in the field.

Finish		
White	One Ckt Two Ckt	81309 82309

Current Limiter



LSI Track Current Limiters integrate directly into single circuit runs, available in the following amperages: 3 AMP (360 Watts); 5 AMP (600 Watts); 8 AMP (960 Watts); 12 AMP (1440 Watts)

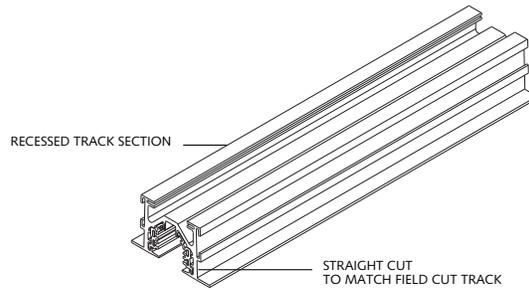
Finish	3 AMP	5 AMP	8 AMP	12 AMP
White	TCLR3W	TCLR5W	TCLR8W	TCLR12W



RECESSED TRACK (120V) • INSTALLATION

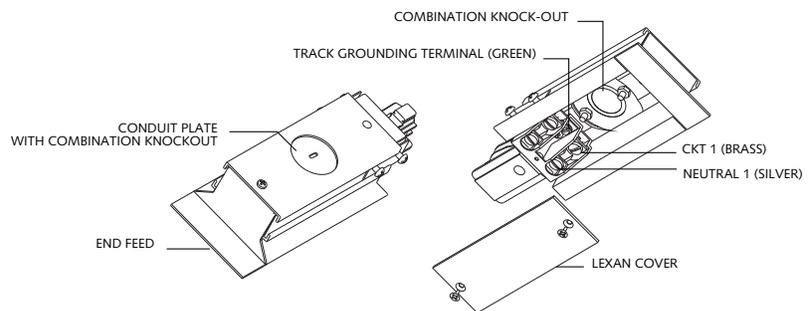
Field Cutting

All LSI Recessed track sections can be easily field cut using a sharp hacksaw or a chop saw with a non-ferrous blade such as an Oldham commercial carbide series metal blade. Cut the aluminum track with one straight cut to the desired length. Be sure to remove any burrs on the aluminum, copper and Noryl™ liner or this may affect the electrical and mechanical connection of components to track.



Electrical

Remove the Lexan™ cover from any End Feed or Joiner/Feeder, bring conductors through combination 1/2, 3/4 U.S. trade size knock-out (.875 diameter [22mm], 1.125 diameter [29mm]) in top of Joiner/Feeder conduit plate knock-out and attach conductors to identified terminals.

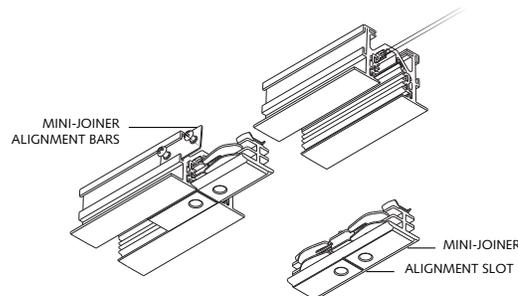


Additional Circuits

LSI Track has integral wiring channels for six additional #12 THHN wires to create three additional 20 amp circuits with separate neutrals. Raceway covers must be used in this application.

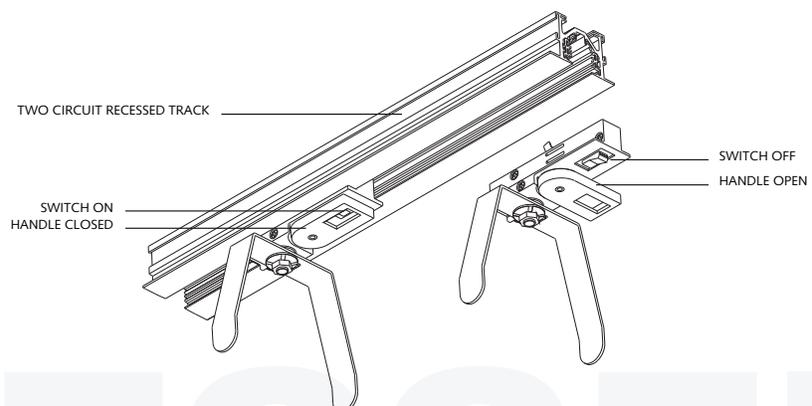
Straight Mini Joiner

The straight mini joiner is used to mechanically couple any two lengths of track in a straight line with a flush fit. Not for use as a feeder. There is an indicator line on face of mini-joiner to ensure proper engagement into each end of track. The two alignment bars with screws, included with the mini-joiner, must be inserted into the track section before joining sections. Tighten screws after alignment has been completed, don't overtighten.



Installing LSI Fixtures

To insert a fixture fitting into the track, the switch must be in the "off" position, with the handle open. Insert the fixture fitting straight up into the track until it seats evenly, close handle completely and switch on. If using one circuit track, make sure that the brass contacts which protrude from the side of the fixture fittings are inserted facing the copper busbars. If using two circuit track, inserting the fixture fitting in one direction will connect to circuit one. Removing and reversing the direction of the fitting will connect to circuit two.



Job Name Here

Designer/Firm Name Here

Ordering Information Here

LUMELX® 2020 SERIES 120/277V • LED



These LED Cylinder units offer high functionality in LSI's smallest, sleekest package.

- 4° optic produces 26000 CBCP with 270 lumens at 5 watts
- System efficiency up to 50 lumens/watt
- Exceeds ANSI specifications by maintaining extremely tight color consistency over the life of the fixture
- Tested to LM79 and LM80 Protocols
- 50,000 hour life to 70% lumen output, L₇₀ at 95°F max ambient
- Hidden integral electronic driver, compatible with trailing edge electronic low voltage dimmers (dimnable to 10%)
- Integral Dimming with built-in potentiometer also available
- Color Rendering Index (CRI) 90+
- Color Fidelity Index (R_f) 92
- Gamut Area Index (R_G) 102
- Color consistency, 2 MacAdam ellipses
- Removable accessory cartridge for any double combination of size-AAA LSI filters and accessories
- No UV or IR emissions; no mercury or lead
- On/off safety switch (on most mounting types)
- Sturdy die-cast aluminum housing
- Self and wrench locking stem for vertical and horizontal focusing
- Finishes: LSI Black, White, and Silver
- Fixture weight: 3 lbs

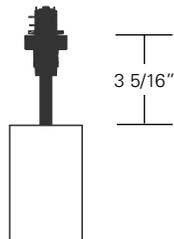
MOUNTING OPTIONS

Please review the **ORDERING INFORMATION** section on the next page on how to specify the following:

- LED Module
- LED Rating
- Color Temperature
- Optic - mm/beam spread
- Dimming
- Voltage
- Finish

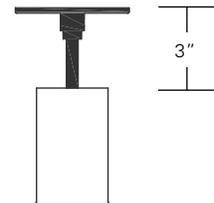
LX2020-XXXXX-XXXXXX-0E-XXXXXX

Lexan Fitting for 1 and 2 circuit LSI Track. With On/Off switch.



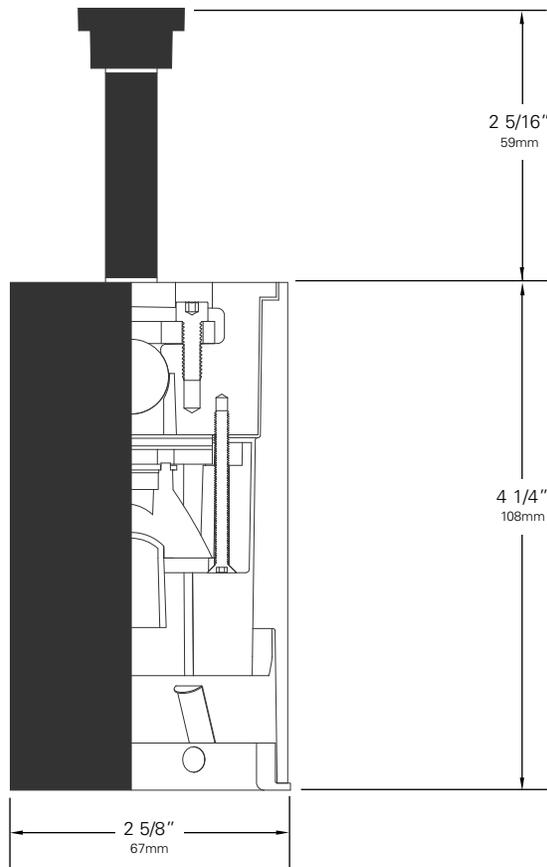
LX2020-XXXXX-XXXXXX-5E-XXXXXX

Canopy for permanent mounting on standard 4" octagonal junction boxes. (2-1/8" deep)



Other Options (Consult Factory):

- Custom stems, specify length (4" – 48")
- Custom color, RAL palette
- Security/Worklite Fixture, use **—EF** as mounting option. (track mount only)

LUMELX® 2020 SERIES 120/277V • LED**ORDERING INFORMATION**

1. Choose the desired LED Module

➔ **(ZE1)** for single LED

2. Choose the letter code to designate the desired LED Rating

Lumens/CRI/Wattage

➔ **(03-90)** for 270/90/5

3. Choose the numeric code to designate the desired

Color Temperature

(27) for 2700K **(30)** for 3000K **(35)** for 3500K

For other CCT, consult factory

4. Use the following numeric code to designate the **Optic**

➔ **(04)** for 35mm/4°

(12) for 35mm/12°

➔ **(25)** for 35mm/25°

5. Select your **Mounting Option**

➔ **(0E)** Track Fitting **(5E)** Canopy Fitting

6. Choose the letter code for **Dimming Type**

➔ **(TE)** Trailing Edge (ELV Reverse Phase) (10%)

➔ **(ED)** Integral Dimming (10%) (0E fitting only)

7. Choose the desired **Voltage:**

➔ **(120)** for 120V

(230) for 220-240V

➔ **(277)** for 277V

➔ 8. Choose a **Finish** for your fixture:

Black **(B)** White **(W)** Silver **(S)**

Example:

LX2020 - ZE1 03-90 30 04 - 0E - TE 120 B

9. Don't forget your Accessories!

DRIVER TYPE (Electronic)

Input Power (A) - 120V	0.04
Input Power (A) - 277V	0.02
Wattage	5
Power Factor - 115V	0.96

ACCESSORIES

- Glass Color Filters AAA
- Louver Hex AAA
- Spread Lenses
AAA990, AAA992,
AAA995, AAA996
50x50 spread lens
- Beam Softener
AAA998
- Light Blocking
Screens AAA801S,
AAA802S, AAA803S
- Color and Spread
Gels AAA
- Backer Ring AAAB

LUMELX® 2020 SERIES • PERFORMANCE

The performance characteristics of the LX2020 family of products can be customized based on the LED module and the optic selected.

Each available LED module is defined by four characteristics – the color rendering index (CRI), the correlated color temperature (CCT), the power that it uses (watts), its “available lumens” and beam spread. Note that available lumens is a theoretical value that represents the light output of the module on its own – no fixture or optic attached.

In the LSI part number, the LED module is specified with a letter and a number that immediately follow the product series number. For example, in the part number LX2020-ZE103-903004-0E-TE120B, the “ZE103-903004” represents an LED module with an output of 270 lumens, a CRI of 90, a power usage of 5 watts, color temperature of 3000K and a 4-Degree beam.

Additional parameters, such as Center Beam Candle Power (CBCP), Delivered Lumens, and Efficiency (Lumens per Watt) are all shown in a table that is organized by LED module and optic combination.

CBCP = Center Beam Candle Power			
LED Module	Optic (Reflector)		
Lumens/CRI/Wattage	04°	12°*	25°*
270/90/5	26000	4100	1100

Delivered Lumens			
LED Module	Optic (Reflector)		
Lumens/CRI/Wattage	04°	12°*	25°*
270/90/5	120	250	240

Efficiency = Lumens Per Watt			
LED Module	Optic (Reflector)		
Lumens/CRI/Wattage	04°	12°*	25°*
270/90/5	24	50	48

*Preliminary data

LED Module Lumens/CRI/Wattage SKU Code	ZE1
Nominal Fixture Power (+/- 20%), Watts	5
Maximum Inrush Current Amps	10
Minimum Power Factor	0.92

Inrush current is instantaneous current drawn by the LED only when fixture is initially powered on or instantaneously changed from full dim to full bright. For more details see Dimming Application Sheet, IS-0119.

MR16 7.5W



OUTPUT RANGE: VIVID SERIES	390 - 455 lumen
OUTPUT RANGE: BRILLIANT SERIES	475 - 525 lumen
BEAM ANGLE RANGE	10°, 25°, 36°
COLOR TEMPERATURE RANGE	2700K, 3000K, 4000K
APPLICATION	Halogen replacement for indoor and outdoor applications



POINT SOURCE OPTICS

Exceptional beam control enables unique 10° narrow spot and smooth uniform beams

Single light source, single crisp shadow

VP₃ VIVID COLOR AND VP₃ NATURAL WHITE

VIVID series provides accurate color rendering across the visible spectrum from 400nm to 700nm, with CRI/95, R9/95, Rf/90, Rg/100

Whiteness rendering matches or exceeds that of halogen and incandescent sources at 2700K and 3000K

ENERGY EFFICIENCY AND LONG LIFE

85% more energy efficient than standard halogen lamps

Typical payback of one year or less

Rated lifetime to L70: 35,000hrs

Warranty: 3yrs or 25,000hrs whichever comes first.

Detailed warranty information available at soraal.com/resources/legal

CERTIFICATIONS

JA8-2016-E, UL/CUL Class 2 and non-Class 2, FCC Title 47 Part 15B, RoHS, CE



HIGHLY COMPATIBLE

Narrow spot compatible with Soraa SNAP System accessories

Geometrically compatible with standard fixtures and suitable for damp locations

This lamp is suitable for use in fully enclosed fixtures, subject to the maximum heatsink temperature limits stated in this data sheet. A list of qualified enclosed fixtures can be found at www.soraal.com/resources

Works with trailing edge and leading edge phase cut dimmers, 12V AC magnetic and electronic transformers and 12V DC transformers (see www.soraal.com/resources)

INTENDED USE AND APPLICATIONS

Intended for use in MR16 compatible recessed downlights, track lighting and other indoor and outdoor applications

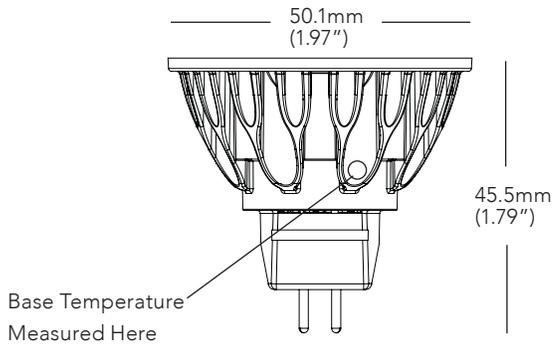
Soraa lamps are designed to safely turn down in any thermal environment not conducive to minimum airflow or proper ventilation

GENERAL SPECIFICATIONS

Form Factor	Operating Temperature	Electrical	Dimming and Flicker
Width: 50.1mm (1.97")	Minimum: -40°C (ambient)	Wattage: 7.5W	Dimmable to <20%
Height: 45.5mm (1.79")	Typical: 85°C - 95°C (base)	Power factor: 0.92	Flicker Index: 0.02
Weight: 47g	Maximum: 100°C (base)	Voltage: 12V +/- 1.2V	Percent Flicker: 5%*
		Frequency: 50/60Hz	

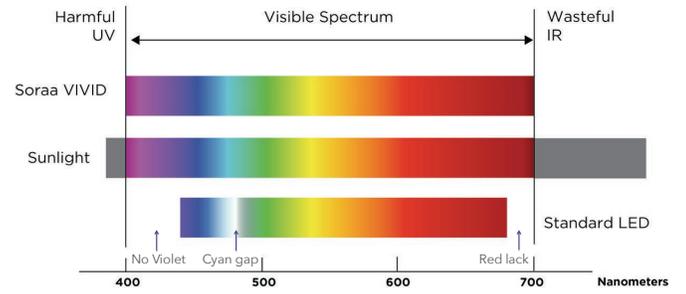
*These Soraa lamps are certified to California's demanding JA8 standard, which requires <30% flicker

DIMENSIONS



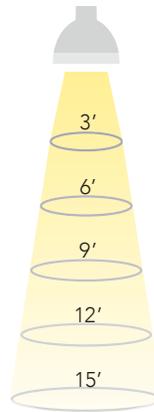
COLOR RENDERING

TYPE L475
AUERBACH·GLASOW



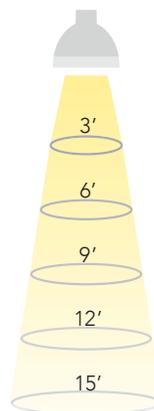
10 DEGREE BEAM

Beam Dia at 50% CBCP (ft)	Field Dia at 10% CBCP (ft)	Foot-candles (% of CBCP)
0.5	1.1	11.1%
1.0	2.1	2.8%
1.6	3.2	1.2%
2.1	4.2	0.7%
2.6	5.3	0.4%



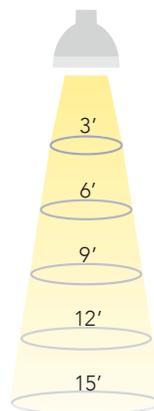
25 DEGREE BEAM

Beam Dia at 50% CBCP (ft)	Field Dia at 10% CBCP (ft)	Foot-candles (% of CBCP)
1.3	2.2	11.1%
2.7	4.4	2.8%
4.0	6.6	1.2%
5.3	8.7	0.7%
6.7	10.9	0.4%



36 DEGREE BEAM

Beam Dia at 50% CBCP (ft)	Field Dia at 10% CBCP (ft)	Foot-candles (% of CBCP)
1.9	3.3	11.1%
3.9	6.5	2.8%
5.8	9.8	1.2%
7.8	13.0	0.7%
9.7	16.3	0.4%



Note: Footcandles may be calculated by multiplying the CBCP of the desired model number by the percentage in the tables above

SPECIFICATIONS BY MODEL NUMBER* SORAA LED MR16 7.5W

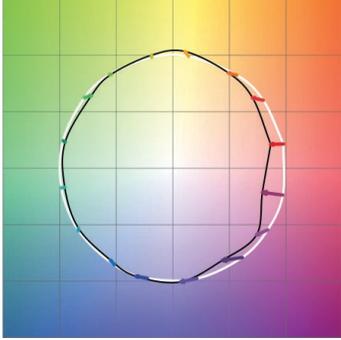
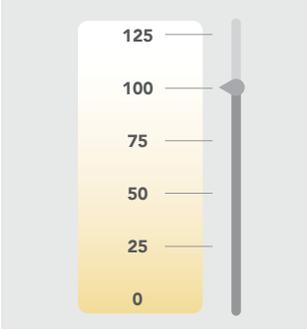
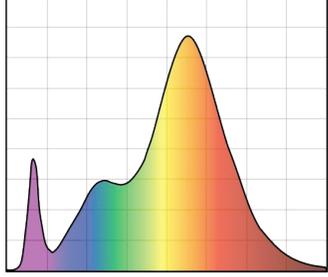
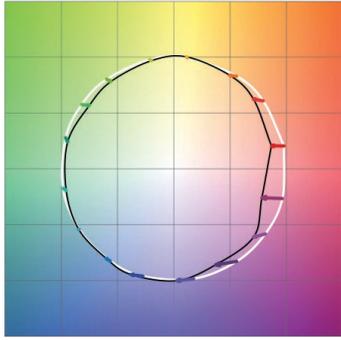
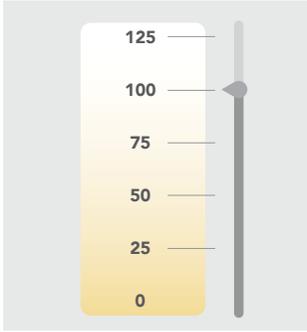
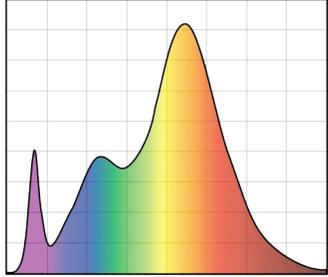
TYPE L475

AUERBACH·GLASOW

Model #	Product Code	CCT (K)	Beam Angle	CBCP (Cd)	Halogen Equivalent	Total Flux (Lm)	Efficacy (Lm/W)	McA	JA8-2016-E	SNAP
VIVID SERIES										
SM16-07-10D-927-03	00919	2700	10	5710	50	390	52	3	YES	YES
SM16-07-25D-927-03	00931	2700	25	2260	50	410	55	3	YES	-
SM16-07-36D-927-03	00943	2700	36	1070	50	410	55	3	YES	-
SM16-07-10D-930-03	00923	3000	10	6000	50	410	55	3	YES	YES
SM16-07-25D-930-03	00935	3000	25	2400	50	435	58	3	YES	-
SM16-07-36D-930-03	00947	3000	36	1130	50	435	58	3	YES	-
SM16-07-10D-940-03	00925	4000	10	6290	50	430	57	4	YES	YES
SM16-07-25D-940-03	00937	4000	25	2510	50	455	61	4	YES	-
SM16-07-36D-940-03	00949	4000	36	1190	50	455	61	4	YES	-
BRILLIANT SERIES										
SM16-07-10D-827-03	00917	2700	10	6950	50	475	63	3	NA	YES
SM16-07-25D-827-03	00929	2700	25	2760	50	500	67	3	NA	-
SM16-07-36D-827-03	00941	2700	36	1310	50	500	67	3	NA	-
SM16-07-10D-830-03	00921	3000	10	7320	50	500	67	3	NA	YES
SM16-07-25D-830-03	00933	3000	25	2900	50	525	70	3	NA	-
SM16-07-36D-830-03	00945	3000	36	1370	50	525	70	3	NA	-

CCT: Correlated Color Temperature **McA:** White Point Accuracy in McA step **SNAP:** SORAA SNAP System Compatible

*Specifications are at stable warm operating conditions (25°C ambient)

<p>BRILLIANT 2700K</p>	 <p>Rf: 85, Rg: 92, Rfh1: 77</p>	 <p>Rw: 100</p>	 <p>CRI: 85, R9: >0</p>
<p>BRILLIANT 3000K</p>	 <p>Rf: 85, Rg: 92, Rfh1: 77</p>	 <p>Rw: 100</p>	 <p>CRI: 85, R9: >0</p>

Rf: TM-30 metric measuring color fidelity (whether colors are similar to those under natural light). Rf is a more accurate version of the CRI Ra. Rf is 100 for natural light.
 Rg: TM-30 metric measuring color gamut (whether colors are more saturated than under natural light). Rg is 100 for natural light.
 Rfh1: TM-30 metric measuring color fidelity for red tones. Rfh1 is a more accurate version of the CRI R9. Rfh1 is 100 for natural light.
 Rw: Soraa-developed metric to measure white fidelity. Rw measures the magnitude of excitation of whitening agents within whites. Rw is about 100 for natural light.

SNAP SYSTEM ACCESSORIES

SMALL (2")

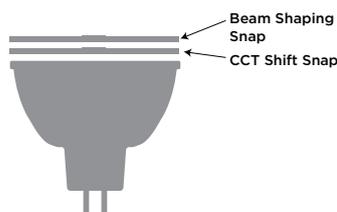


DESCRIPTION

The award winning Soraa SNAP SYSTEM™ is the first LED lamp/accessory solution that is optimized to work as an integrated system. Based on high brightness single source GaN on GaN™ LED technology, it completely redefines accessory application. The effects that can be achieved are similar to what can be done with halogen sources, but are enabled by a relatively low operating temperature and ground-breaking optical design, materials, and methods of attachment.

STACKING ACCESSORIES

SNAP SYSTEM accessories can be stacked in combination. For example, a beam spreader can be used in combination with CCT shifter. When combining the beam shaping Snap accessory with CCT shifting Snap Accessory, for best results always place CCT shifting Snap on the lamp first, as shown in diagram below.



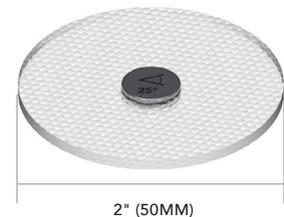
ATTACHMENT

The SNAP SYSTEM's self-centering magnetic interconnect system makes using accessories completely user friendly. Simply attached the SNAP SYSTEM accessory directly to any Narrow Spot Soraa lamp, the magnetic force from both the accessory and lamp will securely attached to one another and center itself.

COMPATIBILITY

The SNAP SYSTEM accessories Small (2") are compatible with the lamps and Optical Light Engines outlined below. The SNAP SYSTEM are only compatible with SORAA Narrow Spot lamps and Optical Light Engines. See each accessory data for exact diameter.

Small (2")
MR16
GU10
PAR20
OLE/C 16



PHOTOMETRICS

IES files of accessories is available for download at http://www.soraa.com/products/snap_system

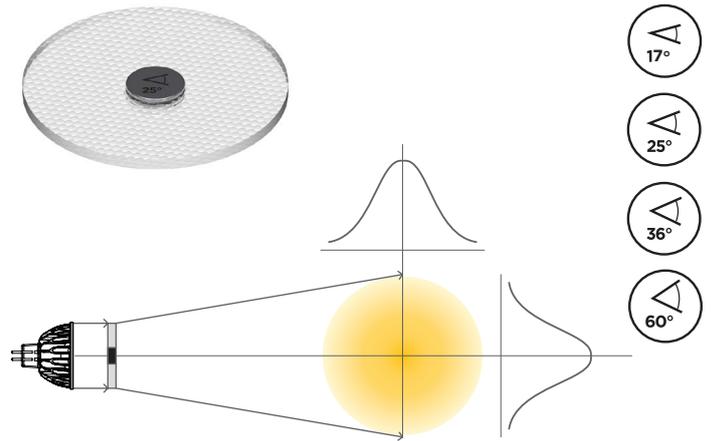
SORAA SNAP SYSTEM LED ACCESSORIES - SMALL (2")

BEAM SPREADER SNAP

Use in any application where reducing the number of beam angle SKUs is required. Reduces inventory costs. Shortens specification, design, sales cycles. Provides maximum flexibility up to the time of installation.

Beam	Part Number	Product Code	CBCP of 10° Lamp	Field Angle
17°	AC-GC-1717-00	03263	30%	33°
25°	AC-GC-2525-00	00325	29%	40°
36°	AC-GC-3636-00	00327	14%	55°
60°	AC-GC-6060-00	00329	5%	103°

Lumen Transmissivity: 90%
Diameter: 50.0 mm Thickness: 2 mm
Magnetic Attach Force: 0.45 lb-F

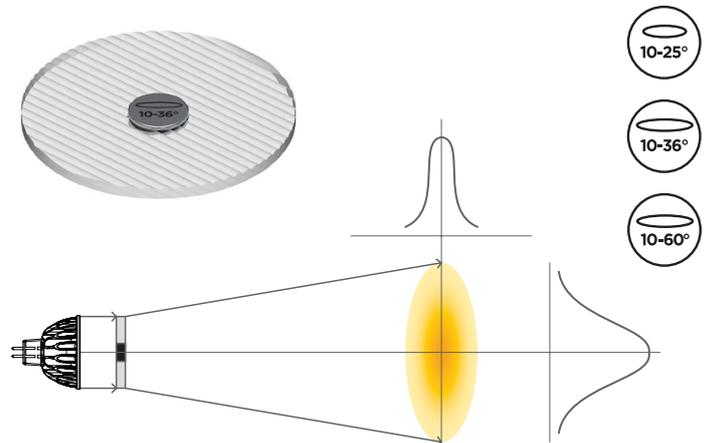


LINEAR SNAP

Use in wall washes and illuminating asymmetric objects. Reduces required number of light fixtures and spill illumination of target objects.

Beam	Part Number	Product Code	CBCP of 10° Lamp	Field Angle Horiz.	Field Angle Vert.
10° - 25°	AC-GE-1025-00	00331	52%	27°	35°
10° - 36°	AC-GE-1036-00	00333	38%	27°	43°
10° - 60°	AC-GE-1060-00	03259	25%	25°	70°

Lumen Transmissivity: 90%
Diameter: 50.0 mm Thickness: 2 mm
Magnetic Attach Force: 0.45 lb-F

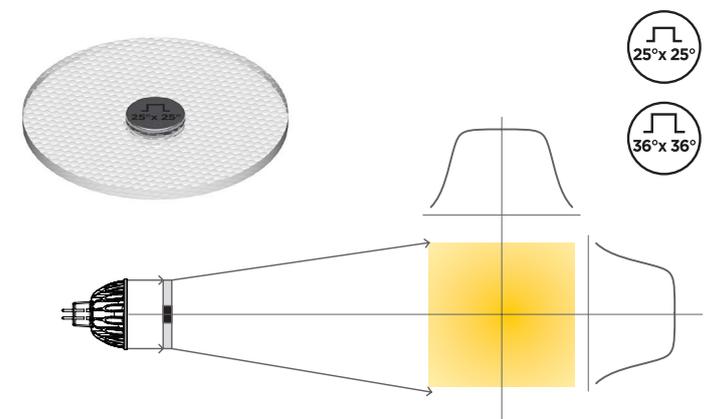


FLAT TOP SNAP

Provides even illumination center to edge. Eliminates video camera saturation, for use in applications such as critical video surveillance.

Beam	Part Number	Product Code	CBCP of 10° Lamp	Field Angle Horiz.	Field Angle Vert.
25° x 25°	AC-FR-2525-00	00335	19%	44°	44°
36° x 36°	AC-FR-3636-00	00337	14%	46°	46°

Lumen Transmissivity: 90%
Diameter: 50.0 mm Thickness: 2 mm
Magnetic Attach Force: 0.45 lb-F



SECTION 265561 THEATRICAL SYSTEMS ELECTRICAL REQUIREMENTS

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
 - f. Section 126600 – Retractable Bleacher System and 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. Under work of this Section, related to Section 126600 - Retractable Bleacher System and Seating
- a. Coordinate with the work of Section 126600 – Retractable Bleacher System and Seating.
 - b. Provide all conduit, wire, wire pulling and termination for telescopic seating unit.
 - c. Provide all local motor disconnects as required to complete system in a code compliant manner.
 - d. Provide terminations for all system electrical safety devices.
 - e. Provide and terminate DMX control circuit for control of aisle lights fed from architectural control system furnished under Section 116163.
 - f. Provide and terminate 120V switched power circuit for relay control of aisle lights fed from relay panel furnished under Section 116163.
12. 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. Submit reports of Factory Acceptance Testing.

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 impermeate 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 impermeate 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 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. Verify 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 then 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
 - (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.
 - (i) Wire map, pin to pin match
 - (ii) Length
 - (iii) Report by frequency:
 - (iv) Insertion loss
 - (v) NEXT, worst pair to pair
 - (vi) Power sum NEXT
 - (vii) ELFEXT, worst pair to pair
 - (viii) Power sum ELFEXT
 - (ix) Return loss
 - (x) 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:
 - (i) The specified cable performance, pro-rated for total link distance.
 - (ii) Multimode:
 - (iii) 1). 0.03 dB for each fusion splice
 - (iv) 2). 0.3 dB for each mechanical splice
 - (v) 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

SECTION 265601 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. Provide dimensioned line drawings for these fixture types:
 - a. Type LE400 series
 - b. Type LE425 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. 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 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

1. See Exterior Light Fixture Schedule in the Electrical drawings for specification information.
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



Luminaire Type:
Catalog Number
(autopopulated):



Gotham Architectural Downlighting
LED Downlights

**2" Incito®
Downlight**

Solid-State Lighting
(US and International Patents Pending)



FEATURES

OPTICAL SYSTEM

- Superior 100% virgin silicone refractive optic enables maximum dimensional stability and optical transmission with no discoloration over life.
- Primary control of distribution occurs in refractive optic allowing for aesthetic versatility with trim color and finish.
- 2.5-step MacAdam Ellipse.
- Thirteen preset distribution patterns allow designers to achieve tailored effects.
- Self-flanged semi-specular or matte-diffuse lower trim.
- Field interchangeable optics.
- 35° shielding angle to refractive optics.

MECHANICAL SYSTEM

- Install from below architecture standard.
- Several additional mounting options available including a structural reinforcement pan, Chicago plenum, and Type IC.
- Standard ambient operating temperature: 25 °C. High ambient option available.
- Accommodates a wide range of applications including multiple plenum cross sections and ceiling thicknesses. Consult page 2.
- Light engine and driver are accessible from above or below ceiling.
- Flangeless trim option includes proprietary Gotham mud ring enabling seamless integration into drywall applications. Mud ring ships separately.

ELECTRICAL SYSTEM

- Solid-state LED light engine available in 2700 K, 3000 K, 3500 K or 4000 K color temperatures. Standard CRI: 80 typical. High CRI option available.
- Rated system life of >60,000 hours at 70% output.
- 120V TRIAC or ELV dimming and 0-10V dimming standard.
- Luminaire accepts parallel and branch circuit control wiring.

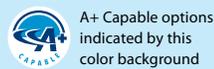
LISTINGS

- Fixtures are UL listed to meet US and Canadian standards; wet location, covered ceiling.
- ENERGY STAR® certified product.

WARRANTY

- 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C.



A+ Capable options indicated by this color background



Design2Ship Quick Ship Program: Options in green text qualify for Design2Ship — 5 business days from order entry to ship. Refer to Design2Ship Brochure for complete program details. **Maximum Order Quantity: 50 units.**

EXAMPLE: IC0 35/10 2AR LSS 20D MVL0T UGZ

Series	Color temperature	Nominal lumen values	Aperture/Trim color	Trim Style	Finish	Beam
IC0	27/ 2700 K	05 500 lumens	2AR Clear	(blank) Self-flanged	LSS Semi-specular	15D 15° beam angle
	30/ 3000 K	07 750 lumens	2PR Pewter	FL Flangeless	LD Matte diffuse	20D 20° beam angle
	35/ 3500 K	10 1000 lumens	2WTR Wheat			25D 25° beam angle
	40/ 4000 K	15 ¹ 1500 lumens	2GR Gold			30D 30° beam angle
			2WR ² White			35D 35° beam angle
			2BR ² Black			40D 40° beam angle
						45D 45° beam angle
					50D 50° beam angle	
					55D 55° beam angle	
					3515D Elliptical 35° x 15° beam angle	
					5020D Elliptical 50° x 20° beam angle	
					5060D Elliptical 50° x 60° beam angle	
					6070D Elliptical 60° x 70° beam angle	

Voltage	Driver	Options
MVL0T ³ 120 277 347 ⁴	UGZ ⁵ Universal dimming to 1% (0-10V, 120V TRIAC or ELV)	SF ^{5,6} Single fuse TRW ^{7,8} White painted flange TRBL ^{8,9} Black painted flange CP ¹ Chicago plenum NPP16D ^{5,6,10} nLight® network power/relay pack with 0-10V dimming. NPP16DER ^{5,6,10} nLight® network power/relay pack with 0-10V dimming. ER control fixtures on emergency circuit.
		CR190 High CRI (90+) HAO ¹ High ambient (40°C) ICAT ¹ IC/Airtight housing construction NCH Structural reinforcement pan **Remotely located eldoLED dimming driver**

ACCESSORIES order as separate catalog numbers (shipped separately)

OPTC2 ¹¹	Additional optics available for field installation	HS258	2-5/8" Hole saw
OPTC2 KIT	Kit including a field interchangeable optic for each of the 13 preset beam distribution patterns	HS234FL	2-3/4" Hole saw for flangeless trim option

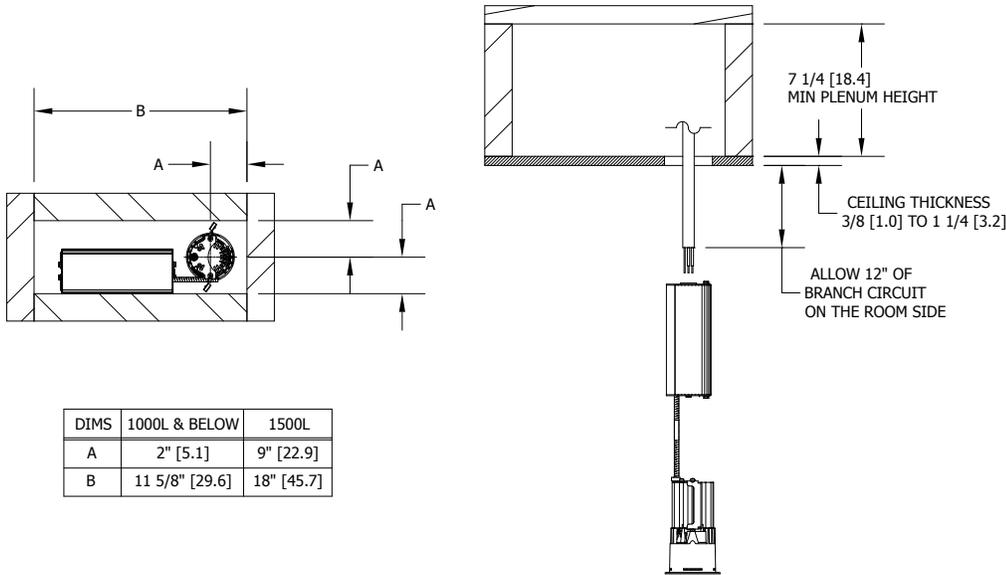
ORDERING INFORMATION



DIMENSIONAL DATA

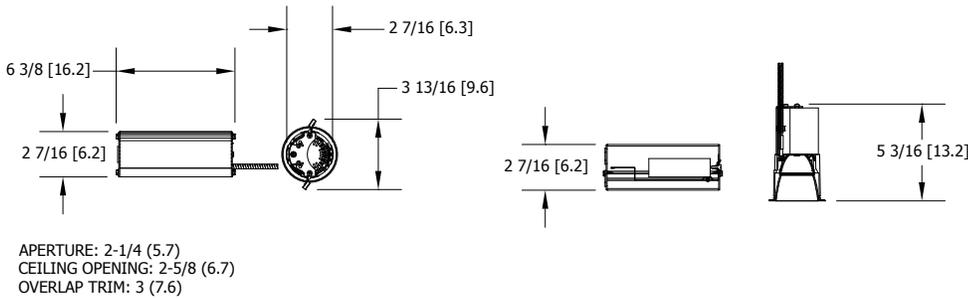
All dimensions are inches (centimeters) unless otherwise noted.

RECESSED APPLICATION — MINIMUM CLEARANCE REQUIREMENTS

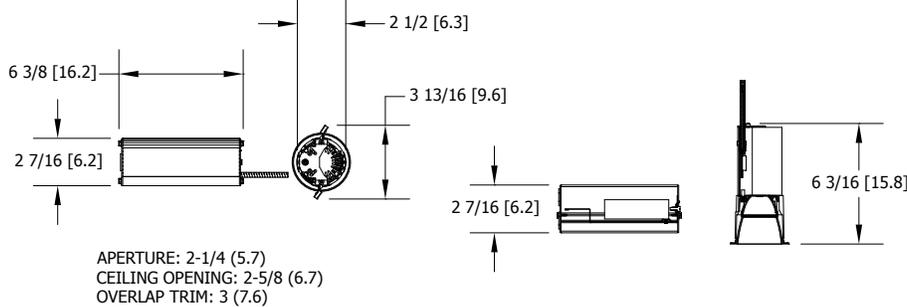


DIMS	1000L & BELOW	1500L
A	2" [5.1]	9" [22.9]
B	11 5/8" [29.6]	18" [45.7]

500, 750, AND 1000 LUMEN INSTALL-FROM-BELOW CONSTRUCTION



1500 LUMEN OR AMBIENT OPTION INSTALL-FROM-BELOW CONSTRUCTION



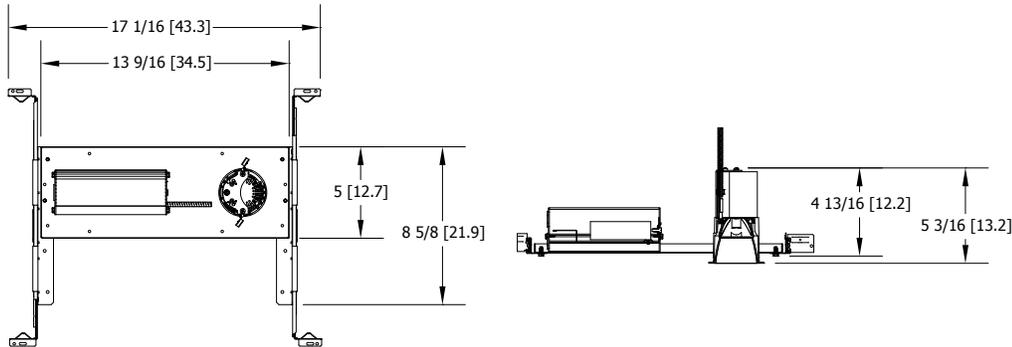
NOTES

ORDERING NOTES

- 1500lm not available with CP, ICAT, or HAO.
- Not available with finishes.
- Multi-volt 120-277V.
- Device must be remote mounted. Will not be factory installed. Access required to location of remote mounted device.
- Refer to [TECH SHEET 240](#) for full list of recommended compatible dimmers. Control system electrical load, and protocol may limit minimum dim level.
- Must specify 120, 277, or 347V.
- Not specifiable with WR reflector.
- Not available with flangeless (FL) trim style.
- Not specifiable with BR reflector.
- Access to nPod necessary for servicing.
- Must specify desired optical distribution from available options in "Beam" column. i.e. OPTC2 15D or OPTC2 3515D. Includes additional capture rings.

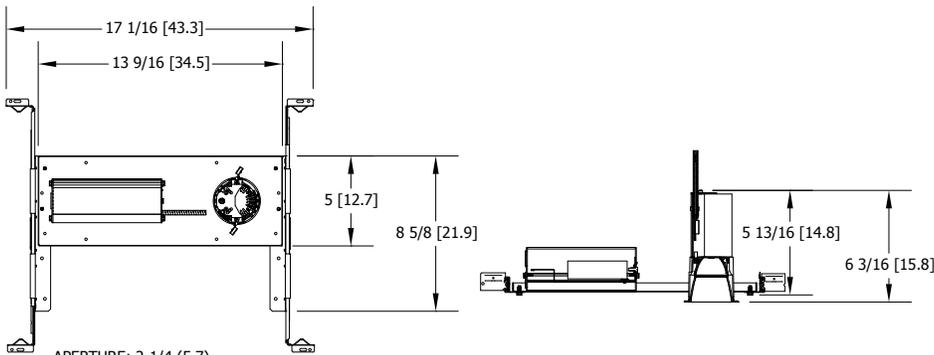
All dimensions are inches (centimeters) unless otherwise noted.

500, 750, AND 1000 LUMEN STRUCTURAL REINFORCEMENT PAN



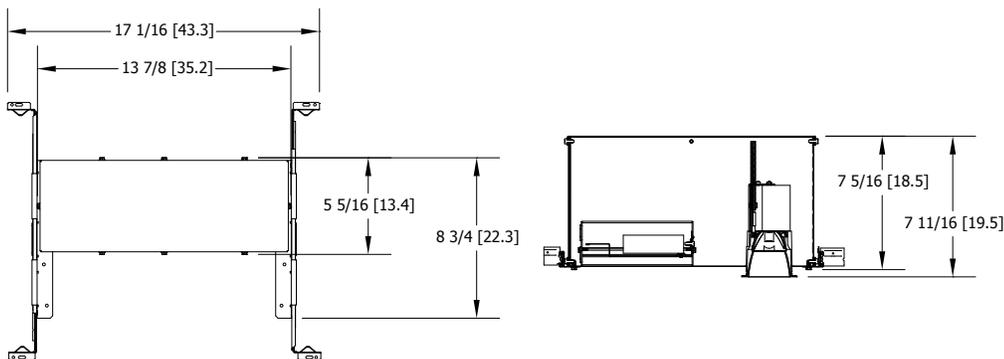
APERTURE: 2-1/4 (5.7)
CEILING OPENING: 2-5/8 (6.7)
OVERLAP TRIM: 3 (7.6)

1500 LUMEN OR HIGH AMBIENT OPTION STRUCTURAL REINFORCEMENT PAN



APERTURE: 2-1/4 (5.7)
CEILING OPENING: 2-5/8 (6.7)
OVERLAP TRIM: 3 (7.6)

IC / AIRTIGHT HOUSING CONSTRUCTION



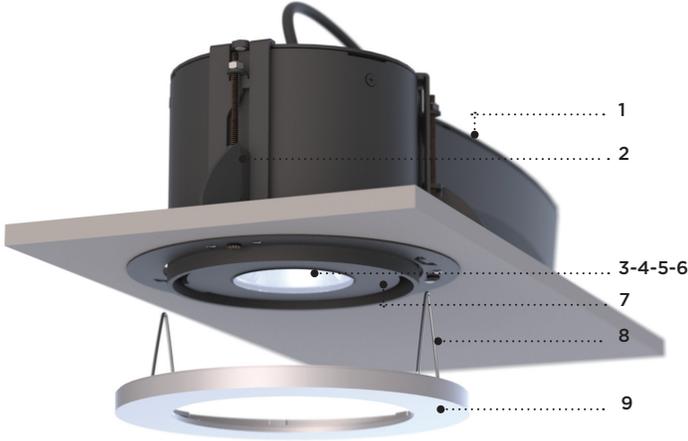
OC950 SERIES
OCULUS - LED
8" EXTERIOR RECESSED DOWNLIGHT



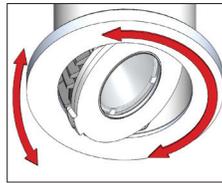
TYPE: _____ QUANTITY: _____ PROJECT: _____

CATALOG NUMBER:

FIXTURE SUFFIX REFLECTOR VOLTAGE FINISH OPTION OPTION OPTION



Oculus light module is designed with a tilting mechanism allowing forward and back light adjustability. The $\pm 30^\circ$ directional module allows the light beam to be aimed in the desired direction, without disturbing the luminaire mounting. Standard fully adjustable 360° rotation.



- 1- Driver housing with gasketed service door.
- 2- Fixture secured with three locking tabs.
- 3- Fully sealed cast aluminum light assembly.
- 4- Sealed cast aluminum lens frame.
- 5- Clear tempered glass lens.
- 6- Faceted specular aluminum reflector.
- 7- Light module. Optional regressed light module.
- 8- Trim secured by two wire springs inserted in slots in the mounting flange.
- 9- Cast aluminum trim available in multiple colors.

All stainless steel hardware.

OC950



OC950-RG



shown with regressed option (RG)

MATERIALS

Oculus is made of corrosion resistant 356 aluminum alloy with a copper (CU) content of less than 0.1%.

The main housing is made of seamless extruded aluminum, with an integrally sealed LED light module designed for optimal heat dissipation, and lighting performance.

Oculus is standard with a unique proprietary design allowing the sealed LED module to tilt within the housing.

Oculus OC950 series is standard with 28° optic. See options section for alternate selection.

ELECTRICAL

DRIVER Standard driver is 0-10V dimming-ready (dims to 10%) with: 120-277 multi-volt compatibility (50-60Hz), operating temperature range of $-40^\circ\text{C}/-40^\circ\text{F}$ to $55^\circ\text{C}/131^\circ\text{F}$, output over voltage protection, output over current protection and output short circuit protection with auto-recovery.

LED Standard 4000K /80CRI. Optional 2700K, 3000K & 3500K. Optional Amber LED for turtle sensitive areas. Wavelengths: 584.5nm to 597nm.

LIFE

60,000hrs $L_{70}B_{50}$ (based on IESNA TM-21 Test Method and LM-80 data). Up to 135,000hrs $L_{70}B_{50}$ (calculated projection from LM-80 data).

FINISH

Five-stage preparation process including preheating of cast aluminum parts for air extraction, and an environmentally friendly alloy sealant. Polyester powder coating is applied through an electrostatic process and oven cured for long term finish.

MOUNTING

Max weight: 17.4 lbs (7.9 kg)

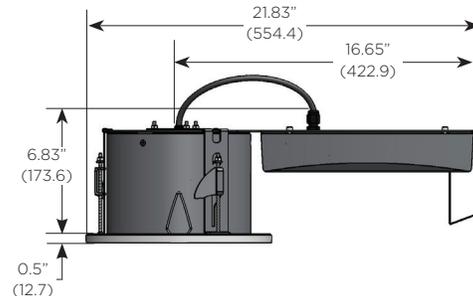
Remodeling type fixture designed to fit in a 9.5" (241mm) dia. opening on a ceiling 0.5" (13mm) to 1.5" (38mm) thick.

3 locking tabs secure frame in the ceiling and trim snaps in place. Locking tabs can be retracted to remove the frame for maintenance. Requires 8" (203) clearance in ceiling.

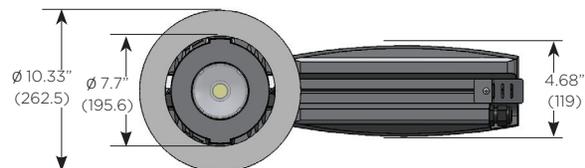
NOTE: Fixture is non-IC rated. For IC, please consult factory.

CERTIFICATION

Tested to UL1598 and CSA 22.2 #250. ETL listed wet location. Rated IP66. CE Certification on request.



Note: Requires 8" (203) clearance in ceiling



LUMINAIRE SELECTION

MODEL#	LED LIGHT SELECTION	REFLECTORS	VOLTAGE	FINISH																				
 <p><input type="checkbox"/> OC950</p>	<table border="1"> <thead> <tr> <th>SUFFIX</th> <th>INPUT WATTS</th> <th>DELIVERED LUMENS</th> <th>CRI</th> <th>CCT °K</th> </tr> </thead> <tbody> <tr> <td><input type="checkbox"/> L1L20</td> <td>20W</td> <td>2157</td> <td>80</td> <td>4000</td> </tr> <tr> <td><input type="checkbox"/> L1L40</td> <td>40W</td> <td>4092</td> <td>80</td> <td>4000</td> </tr> <tr> <td><input type="checkbox"/> L1L60</td> <td>61W</td> <td>5878¹</td> <td>80</td> <td>4000</td> </tr> </tbody> </table> <p>AMBER LED IDA - Dark Sky Approved</p> <p><input type="checkbox"/> L1L4K2A 11W 440 AMBER</p>	SUFFIX	INPUT WATTS	DELIVERED LUMENS	CRI	CCT °K	<input type="checkbox"/> L1L20	20W	2157	80	4000	<input type="checkbox"/> L1L40	40W	4092	80	4000	<input type="checkbox"/> L1L60	61W	5878 ¹	80	4000	<p><input type="checkbox"/> R15 Narrow optics 12° (not available on L1L60)</p> <p><input type="checkbox"/> R30 Flood optics 28° (standard)</p> <p><input type="checkbox"/> R40 Flood optics 38°</p> <p><input type="checkbox"/> R55 Wide flood optics 55°</p>	<p><input type="checkbox"/> 120V</p> <p><input type="checkbox"/> 277V</p> <p>Optional</p> <p><input type="checkbox"/> 347V</p>	<p>TRIM & LIGHT MODULE COLOR (select one)</p> <p>STANDARD COLORS</p> <p><input type="checkbox"/> WHT Snow white</p> <p><input type="checkbox"/> BKT Jet black</p> <p><input type="checkbox"/> BZT Bronze</p> <p><input type="checkbox"/> MST Matte silver</p> <p><input type="checkbox"/> GRT Titanium gray</p> <p><input type="checkbox"/> DGT Gun metal</p> <p><input type="checkbox"/> CHT Champagne</p> <p>OPTIONAL COLORS</p> <p><input type="checkbox"/> CS Custom color</p> <p><input type="checkbox"/> RAL RAL# color</p> <p>NATATORIUM SUITED COLORS</p> <p><input type="checkbox"/> NWHT White</p> <p><input type="checkbox"/> NBKT Black</p>
	SUFFIX	INPUT WATTS	DELIVERED LUMENS	CRI	CCT °K																			
<input type="checkbox"/> L1L20	20W	2157	80	4000																				
<input type="checkbox"/> L1L40	40W	4092	80	4000																				
<input type="checkbox"/> L1L60	61W	5878 ¹	80	4000																				
<p>VERY NARROW DISTRIBUTION</p> <p><input type="checkbox"/> L1L25NR 44W 2565 80 4000</p>	<p><input type="checkbox"/> R9 Very narrow optics 9° (56,363 candela)</p>																							

OPTIONS

LIGHT & OPTICS

- Alternate CCT °K LED (LCF: Lumen conversion factor)
- K27** 2700K CCT 80 CRI (LCF: 0.91)² IDA - Dark Sky Approved
 - K3** 3000K CCT 80 CRI (LCF: 0.94) IDA - Dark Sky Approved
 - K35** 3500K CCT 80 CRI (LCF: 0.983)²

NOTE: Other CCT & higher CRI available, please consult factory.

- RG** Regressed light module (light module color is BKT when RG is selected, trim color must still be chosen, not limited to BKT)³

EMERGENCY

- REML2-50** 7W remote emergency battery backup for LED, 90 min. Remote mount 50ft - 12" (305) square enclosure with access cover.⁴

ELECTRICAL

- FS** Fuse
- DMX/RDM** DMX/RDM control dim to dark (0%)⁵
- RD** Remote driver. Consult factory.

ACCESSORIES

- CPB** Concrete pour box
- HL** Hexcell louver
- SL** Solite lens
- LSL** Linear spread lens (Asymmetric lens distribution is achieved when light module is tilted)
- GL** Trim glass for water ingress protection in ceiling

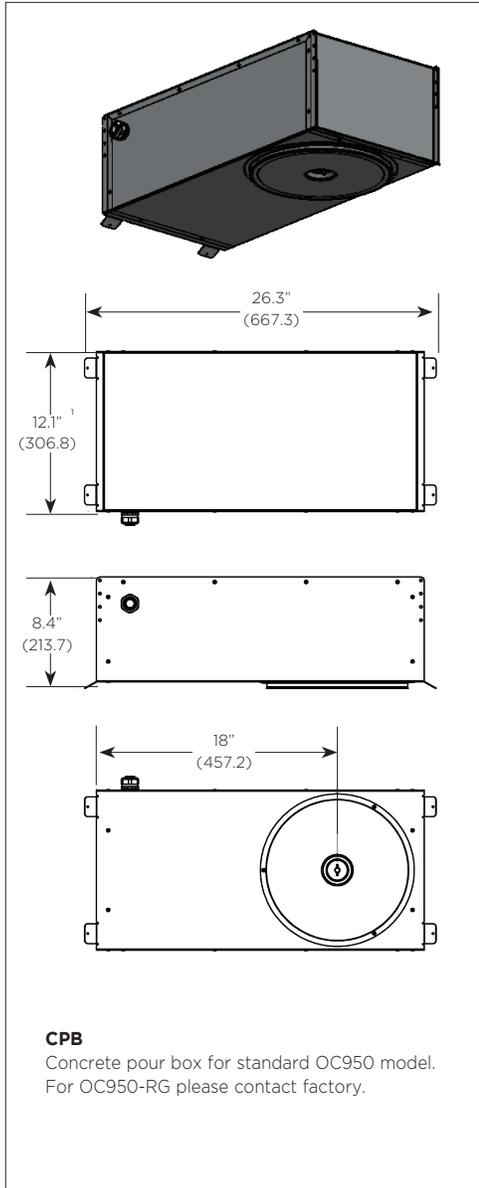
NOTES

- 1- 4818 delivered lumens with GL option. 5466 delivered lumens with DMX/RDM option.
- 2- Please consult factory when selecting K27 or K35 in conjunction with R9 (very narrow optics)
- 3- Cylindrical housing extended by 1" (25.4) for increased cut-off
- 4- The remote enclosure must be interior.
- 5- Default dimming curve: Logarithmic. Factory set to address one unless otherwise specified. Refer to DMX Reference Guide for more information (available on website).

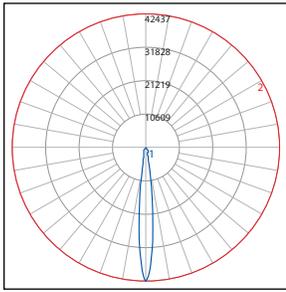


OPTIONS

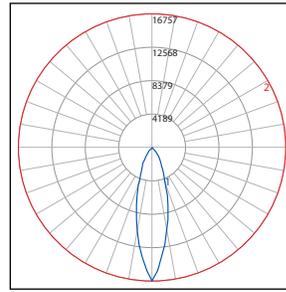
ACCESSORIES



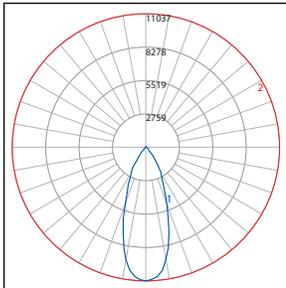
TYPICAL PHOTOMETRY SUMMARY



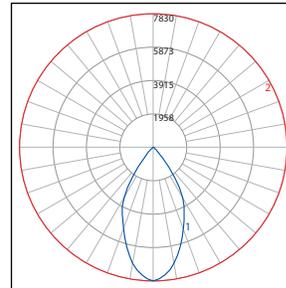
Descriptive Information
OC950-L1L40-R15
Total Lms: 3952 Lumens
Total Input Watts: 45 W
Efficacy: 88 Lumens/Watt
BUG: B3-U0-G0
CCT/CRI: 4000K/80
Maximum Candela: 42437 @ 0 deg



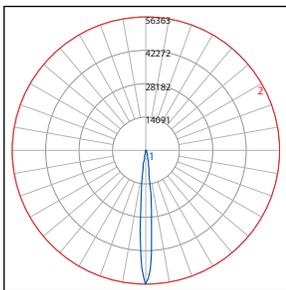
Descriptive Information
OC950-L1L60-R30
Total Lms: 5878 Lumens
Total Input Watts: 61 W
Efficacy: 97 Lumens/Watt
BUG: B3-U0-G0
CCT/CRI: 4000K/80
Maximum Candela: 16757 @ 0 deg



Descriptive Information
OC950-L1L60-R40
Total Lms: 5583 Lumens
Total Input Watts: 61 W
Efficacy: 92 Lumens/Watt
BUG: B3-U0-G0
CCT/CRI: 4000K/80
Maximum Candela: 11037 @ 0 deg



Descriptive Information
OC950-L1L60-R55
Total Lms: 5947 Lumens
Total Input Watts: 61 W
Efficacy: 98 Lumens/Watt
BUG: B3-U0-G0
CCT/CRI: 4000K/80
Maximum Candela: 7830 @ 0 deg

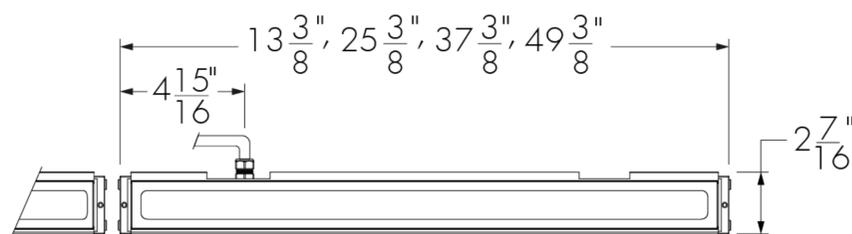


Descriptive Information
OC950-L1L25NR-R9
Total Lms: 2565 Lumens
Total Input Watts: 44 W
Efficacy: 58 Lumens/Watt
BUG: B3-U0-G0
CCT/CRI: 4000K/80
Maximum Candela: 56363 @ 0 deg

Please visit our web site www.luminis.com for complete I.E.S. formatted download data.

Project Name _____ Qty _____

Type _____ Catalog / Part Number _____



Top view



Front and side views

Photometric Summary

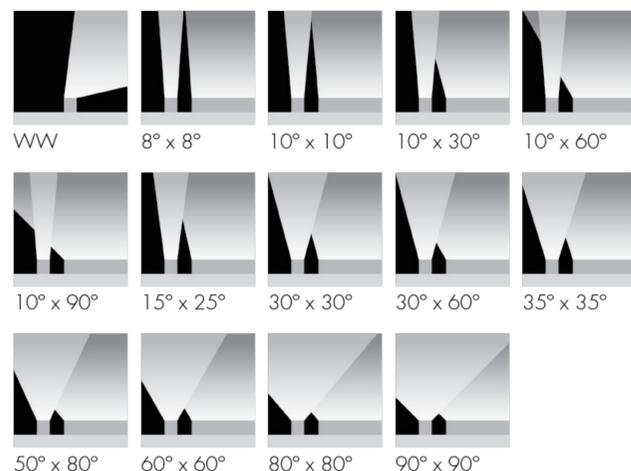
	Delivered output (lm)	Intensity (peak cd)
WW	3,592	5,159
8°x8°	4,045	77,896
10°x10°	3,768*	38,346*
10°x30°	3,830	30,056
10°x60°	3,692	19,654
10°x90°	3,576	7,897
30°x30°	3,765	14,726
30°x60°	3,862*	5,119*
60°x60°	3,447*	3,015*
90°x90°	3,592	1,886

Based on HO 4000K, 4ft [1219mm] configuration.

Photometric performance is measured in compliance with IESNA LM-79-08.

*Estimated. Consult website for the latest photometric files.

Optics



Description

The Lumenfacade Remote is a high-performance, linear LED luminaire for grazing and flood-lighting facades. It has a remote power supply, which makes the fixture profile very slim and therefore easier to integrate into architecture. Featuring second generation LED technology, the luminaire is available in 12 in, 24 in, 36 in or 48 in sections, and can be configured with a wide number of options including: optics for grazing or flood lighting; a choice of outputs (ASHRAE 4.2 W/ft, RO 7.5 W/ft or HO 15 W/ft); various color temperatures or static colors; various mounting options, finishes, accessories and controls. The Lumenfacade is also available with a unique asymmetric wallwash distribution, providing exceptional uniformity and brightness for walls and signage.

Features

Color and Color Temperature	2200K, 2700K, 3000K, 3500K, 4000K, Red, Green, Blue
Length (nominal)	12 in, 24 in, 36 in, 48 in
Optics	Asymmetric Wallwash, 8° x 8°, 10° x 10°, 10° x 30°, 10° x 60°, 10° x 90°, 15° x 25°, 30° x 30°, 30° x 60°, 35° x 35°, 50° x 80°, 60° x 60°, 80° x 80°, 90° x 90°
Options	Corrosion-resistant coating for hostile environments, 3G ANSI C136.31 Vibration Rating for bridge applications
Power Consumption	4.2 W/ft DC (meets ASHRAE standards for linear lighting on building facades - not available for 12 in fixture lengths), 7.5 W/ft DC (RO version), 15 W/ft DC (HO version)
Warranty	5-year limited warranty

Colors and Color Temperatures



Controls

ON/OFF 0-10V DALI DMXrdm

Ratings

IP66 IK07*
 *asymmetric wallwash lens is IK06 rated

Certifications



Performance

Illuminance at Distance	Minimum 1 fc at 140 ft (HO 4000K, 48 in fixture, 10° x 60°)
Color Consistency	2 SDCM, 3 SDCM (2200K)
Color Rendering	Minimum CRI 80
Lumen Maintenance	L70 280,000 hrs, L95 35,000 hrs

Physical

Housing Material	Low copper content extruded aluminum
Lens Material	Clear tempered glass
Hardware Material	Stainless steel
End Cap Material	Machined aluminum
Gasket Material	Silicone
Surface Finish	Electrostatically applied polyester powder coat
Weight	12 in: 2.1 lbs, 24 in: 3.9 lbs, 36 in: 5.6 lbs, 48 in: 7.4 lbs

Electrical and control

Voltage	24V DC, Remote power & data supply required
Fixture Cable	Power and data in one cable
Conductors	4C #16-4
Control	On/Off control, 0-10V dimming, DALI dimming, DMX enabled, Lumentalk system is enabled with LDB accessory - see typical wiring diagrams for details
Resolution (DMX)	Per foot or per fixture

Environmental

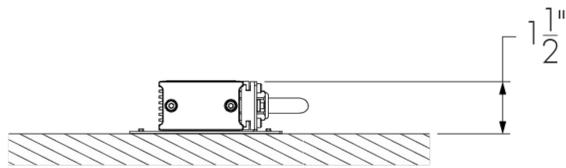
Storage Temperature	-40 °F to 185 °F (device must reach start-up temperature value before operating)
Start-up Temperature	-13 °F to 122 °F
Operating Temperature	-40 °F to 122 °F
Ingress Protection Rating	IP66
Impact Resistance Rating	IK07 (asymmetric wallwash lens is IK06 rated)

Accessories (order separately)

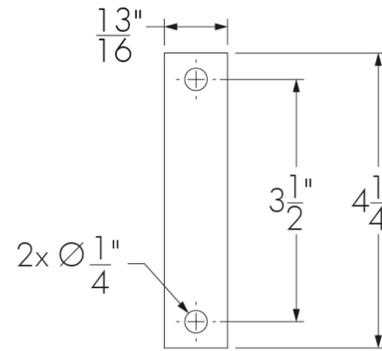
Optical Accessories	Lumenfacade Remote Radial Louver
Power Supply and Dimming Boxes	Power supply box
Control and Power Supply Boxes	DMX/RDM control box, Lumentalk Data Bridge
Control Systems	Lumentone™ 2, Pharos® kit
Diagnostic and Addressing Tools	LumenID, LumentalkID

Mounting options

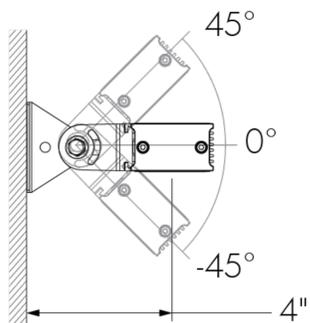
UMPR - Fixed Mounting Remote version



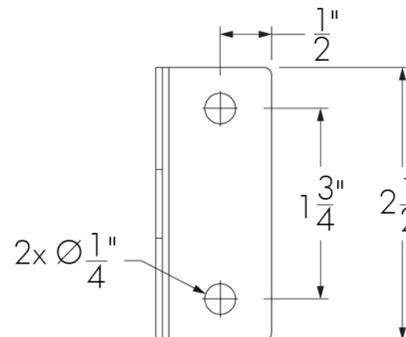
UMPR - Mounting hole pattern



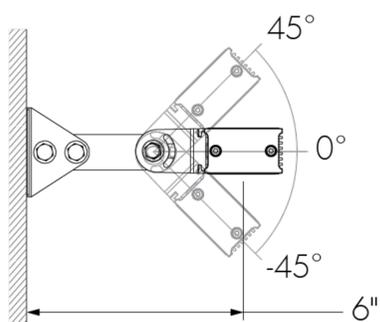
WAMR3 - Adjustable Arm Mounting 3 in Remote version



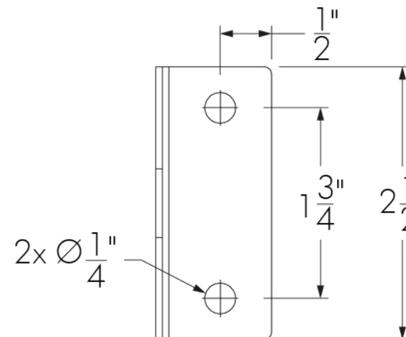
WAMR3 - Mounting hole pattern



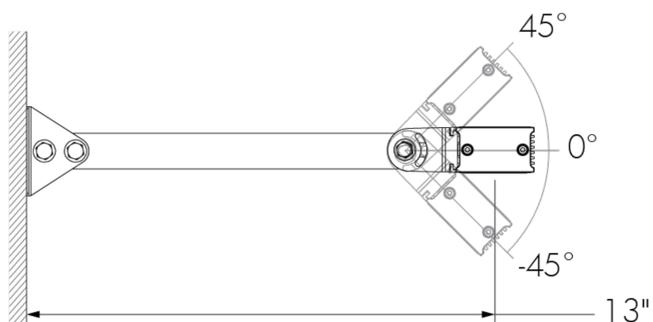
WAMR6 - Adjustable Arm Mounting 6 in Remote version



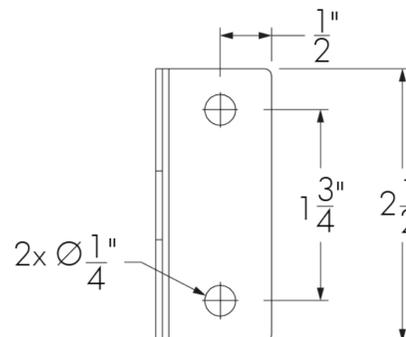
WAMR6 - Mounting hole pattern



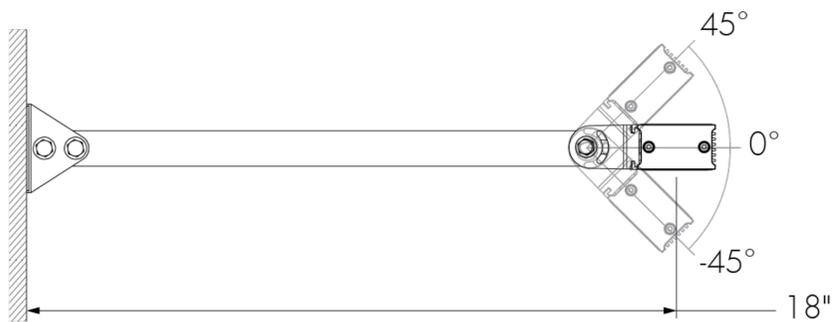
WAMR12 - Adjustable Arm Mounting 12 in Remote version



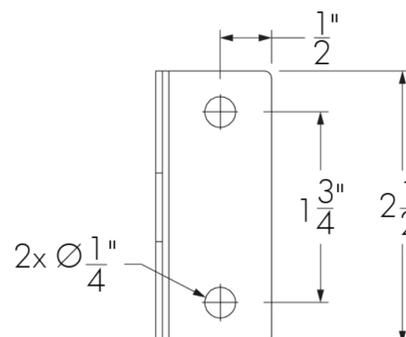
WAMR12 - Mounting hole pattern



WAMR18 - Adjustable Arm Mounting 18 in Remote version

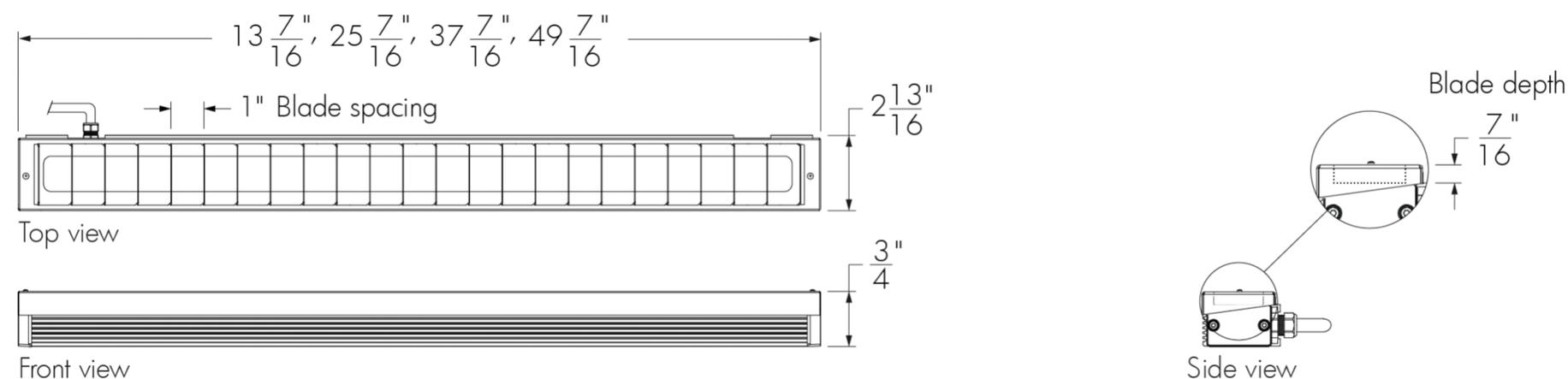


WAMR18 - Mounting hole pattern



Optical accessories (order separately)

LOGRRD - Radial louver for Lumenfacade Remote



LOGRRD-LENGTH-FINISH-OPTIONS

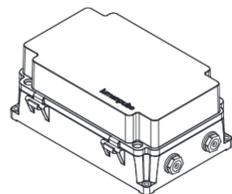
Please specify:

LENGTH: 12 in, 24 in, 36 in or 48 in; **FINISH:** BK - Black Sandtex®, BRZ - Bronze Sandtex®, SI - Silver Sandtex®, WH - Smooth white or CC - custom color and finish (please specify RAL color); **OPTIONS:** CRC - Corrosion-resistant coating for hostile environments

- The addition of a louver will affect beam distribution. Consult factory for application support.
- Not suitable for asymmetric wallwash optic.
- Two mounting screws included.

Power supply and dimming boxes (order separately)

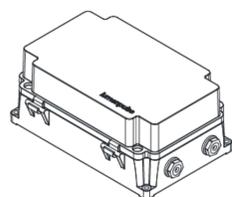
PSX60-100 - Power supply box



Power supply box. Up to six low voltage power outputs to fixtures or fixture runs. Consult PSX60, PSX100 specification sheet for details.

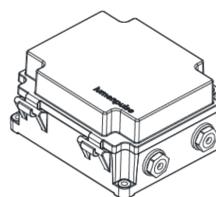
Control and power supply boxes (order separately)

CBX60-100 - DMX/RDM control box



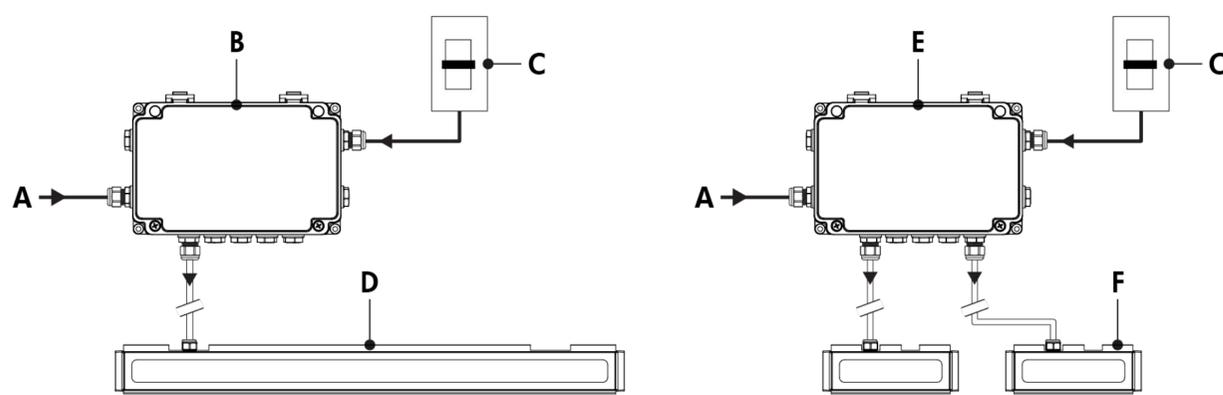
DMX/RDM control box. Up to six low voltage power and data outputs to fixtures or fixture runs. Consult CBX60, CBX100 specification sheet for details.

LDB - Lumentalk Data Bridge



Lumentalk Data Bridge, 0-10V or DMX output. Consult LDB specification sheet for details.

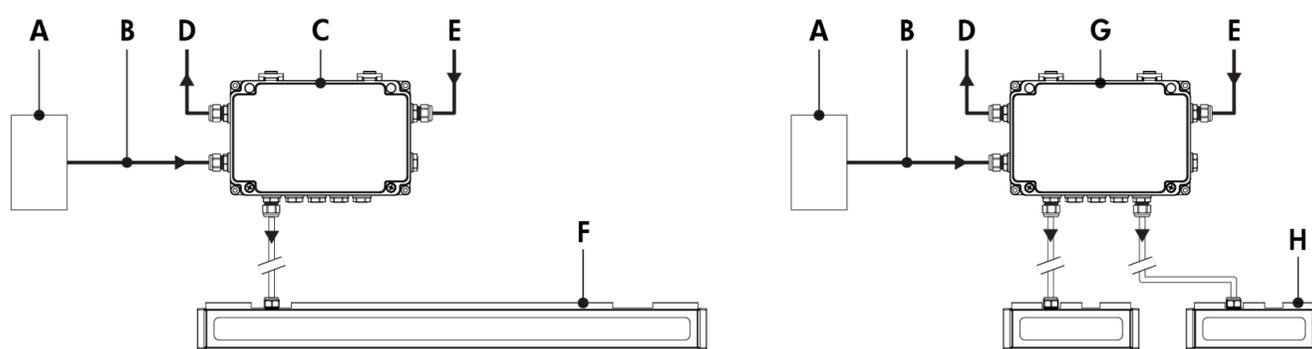
0-10V dimming (DIM)



- A** - Power input (100-277V, wiring by others)
- B** - PSX60-010
- C** - Dimmer (by others)
- D** - Lumenfacade Remote
- E** - PSX100-010
- F** - Lumenfacade Remote

- Consult PSX installation instructions for additional wiring details.
- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- Output quantity depends on the project layout. Up to 6 outputs to fixtures available. Make sure the total load of all the fixture runs does not exceed the capacity of the PSX.
- 0-10V mA ratings: passive dimmer (Current Sink): 3 mA per fixture, active dimmer (Current Source): 0.5 mA per fixture.
- 10% minimum dimming value.
- ASHRAE version (not available for 12 in fixture lengths): 4.2 W/ft DC; Regular Output version: 7.5 W/ft DC; High Output version: 15 W/ft DC.

DMX dimming (DMX)



- A** - DMX controller (order separately from Lumenpulse, or by others)
- B** - Data input (Belden 9841 or equivalent, by others)
- C** - CBX60
- D** - Data output to next CBX60 or CBX100 (optional, not isolated/not boosted)
- E** - Power input (100-277V, wiring by others)
- F** - Lumenfacade Remote
- G** - CBX100
- H** - Lumenfacade Remote

- Consult CBX60/CBX100 installation instructions for additional wiring details.
- Consult factory for specific applications and maximum fixture count/cable length recommendations.
- Maximum of 6 outputs per CBX60 or CBX100.
- 1% minimum dimming value.
- ASHRAE version (not available for 12 in fixture lengths): 4.2 W/ft DC; Regular Output version: 7.5 W/ft DC; High Output version: 15 W/ft DC.

How to order

1	2	3	4	5	6	7	8
9	10						

1 . Housing

LOGR ASHRAE	Lumenfacade™ Remote Power Supply, 4.2 W/ft DC ASHRAE compliant ⁽¹⁾
LOGR RO	Lumenfacade™ Remote Power Supply, Regular Output 7.5 W/ft DC
LOGR HO	Lumenfacade™ Remote Power Supply, High Output 15 W/ft DC

⁽¹⁾ ASHRAE version not available for 12 in fixture lengths.

2 . Cable Length

10FT	10 ft
20FT	20 ft
30FT	30 ft
50FT	50 ft
70FT	70 ft
100FT	100 ft

3 . Voltage

24V	24V DC fixture
------------	----------------

4 . Length

12	13 3/8 in (2.1 lbs) ⁽¹⁾
24	25 3/8 in (3.9 lbs)
36	37 3/8 in (5.6 lbs)
48	49 3/8 in (7.4 lbs)

⁽¹⁾ To connect to the Lumentalk system, DIM, DMX 1FT or DMX 1FX must be specified as the control option, and a Lumentalk Data Bridge (LDB) is required. See the typical wiring diagrams in the specification sheet for details.

5 . Color and Color Temperature ⁽¹⁾

22K	2200K
27K	2700K
30K	3000K
35K	3500K
40K	4000K
RD	Red ⁽²⁾
GR	Green ⁽²⁾
BL	Blue ⁽²⁾

⁽¹⁾ Consult factory for availability of static Royal Blue, 6500K and 90+ CRI.

⁽²⁾ Static colors made to order 8-10 weeks.

6 . Optics

WW	Asymmetric Wallwash
8x8	8° x 8° ⁽¹⁾
10x10	10° x 10° ⁽¹⁾
10x30	10° x 30°
10x60	10° x 60°
10x90	10° x 90°
15x25	15° x 25°
30x30	30° x 30°
30x60	30° x 60°
35x35	35° x 35°
50x80	50° x 80°
60x60	60° x 60°
80x80	80° x 80°
90x90	90° x 90°

⁽¹⁾ For best results use with HO fixtures at a 6 in setback from surface. Contact factory for application support.

9 . Control ⁽¹⁾ ⁽²⁾

NO	On/Off control
DIM	0-10V dimming
DALI	DALI dimming
DMX 1FT	DMX dimming — resolution per foot
DMX 1FX	DMX dimming — resolution per fixture

⁽¹⁾ To connect to the Lumentalk system, DIM, DMX 1FT or DMX 1FX must be specified as the control option, and a Lumentalk Data Bridge (LDB) is required. See the typical wiring diagrams in the specification sheet for details.

⁽²⁾ A Lumentranslator and LumentalkID (LIDLT) must be specified for Lumentalk applications. Consult Lumentranslator and Lumentalk pages and specification sheets for details.

7 . Mounting Options

UMPR	Fixed Mounting Remote version ⁽¹⁾
WAMR3	Adjustable Arm Mounting 3 in Remote version
WAMR6	Adjustable Arm Mounting 6 in Remote version
WAMR12	Adjustable Arm Mounting 12 in Remote version
WAMR18	Adjustable Arm Mounting 18 in Remote version

⁽¹⁾ Suitable to use when 3GV option is specified.

8 . Finish

BK	Black Sandtex®
BRZ	Bronze Sandtex®
SI	Silver Sandtex®
WH	Smooth white
CC	Custom color and finish (please specify RAL color) ⁽¹⁾

⁽¹⁾ Lumenpulse offers a wide selection of RAL CLASSIC (K7) colors with a smooth texture and high-gloss finish. Please consult factory for a list of available K7 colors, other RAL textures and glosses, or to match alternate color charts. Final color matching results may vary.

10 . Options

CRC	Corrosion-resistant coating for hostile environments ⁽¹⁾
3GV	3G ANSI C136.31 Vibration Rating for bridge applications ⁽²⁾

⁽¹⁾ Use only when exposed to salt spray and harsh chemicals. This option is not required for normal outdoor exposure.

⁽²⁾ Available with UMPR mounting option only.

Application

LED recessed wall luminaire with asymmetrical light distribution for the illumination of ground surfaces, building entrances, stairs and footpaths.

Materials

Luminaire housing and faceplate constructed of die-cast aluminum marine grade, copper free ($\leq 0.3\%$ copper content) A360.0 aluminum alloy
Clear safety glass
Silicone applied robotically to casting, plasma treated for increased adhesion
High temperature silicone gasket
Mechanically captive stainless steel fasteners
Stainless steel screw clamps
Composite installation housing

NRTL listed to North American Standards, suitable for wet locations
Protection class IP65
Weight: 4.0 lbs

Electrical

Operating voltage	120-277V AC
Minimum start temperature	-30° C
LED module wattage	12.3 W
System wattage	15.0 W
Controlability	0-10V
Color rendering index	Ra > 80
Luminaire lumens	1,000 lumens (3000K)
Lifetime at Ta=15°C	230,000 h (L70)
Lifetime at Ta=35°C	80,000 h (L70)

LED color temperature

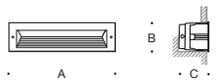
2700K - Product number + **K27**
3000K - Product number + **K3**
3500K - Product number + **K35**
4000K - Product number + **K4**

BEGA can supply you with suitable LED replacement modules for up to 20 years after the purchase of LED luminaires - see website for details

Finish

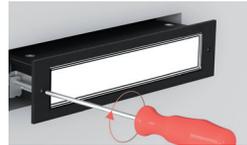
All BEGA standard finishes are matte, textured polyester powder coat with minimum 3 mil thickness.

Available colors	Black (BLK)	White (WHT)	RAL:
	Bronze (BRZ)	Silver (SLV)	CUS:

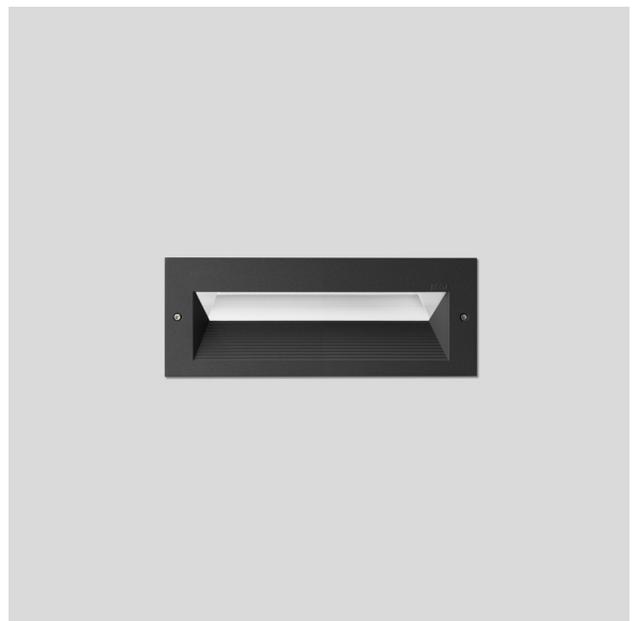


LED recessed wall luminaires · asymmetrical				
	LED	A	B	C
33058	12.3W	13	5	5 1/2

Type:
BEGA Product:
Project:
Modified:



Fully enclosed luminaire with installation housing ensures seamless integration and weathertight operation.



Application

LED wall mounted luminaires with directed light designed to be mounted at various heights for general purpose illumination or glare free illumination when below eye level.

Materials

Luminaire housing constructed of die-cast marine grade, copper free ($\leq 0.3\%$ copper content) A360.0 aluminum alloy
 Matte safety glass
 Silicone applied robotically to casting, plasma treated for increased adhesion
 High temperature silicone gasket
 Mechanically captive stainless steel fasteners

NRTL listed to North American Standards, suitable for wet locations
 Protection class IP65
 Weight: 3.6lbs

Electrical

Operating voltage	120-277VAC
Minimum start temperature	-40° C
LED module wattage	12.3W
System wattage	15.0W
Controllability	0-10V, TRIAC, and ELV dimmable
Color rendering index	Ra > 80
Luminaire lumens	1,077 lumens (3000K)
Lifetime at Ta = 15° C	> 500,000 h (L70)
Lifetime at Ta = 45° C	108,000 h (L70)

LED color temperature

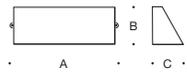
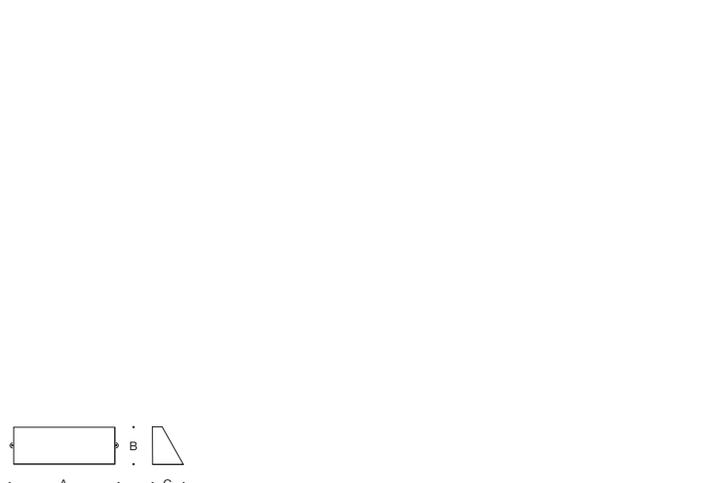
- 4000K - Product number + **K4**
- 3500K - Product number + **K35**
- 3000K - Product number + **K3**
- 2700K - Product number + **K27**

BEGA can supply you with suitable LED replacement modules for up to 20 years after the purchase of LED luminaires - see website for details

Finish

All BEGA standard finishes are matte, textured polyester powder coat with minimum 3 mil thickness.

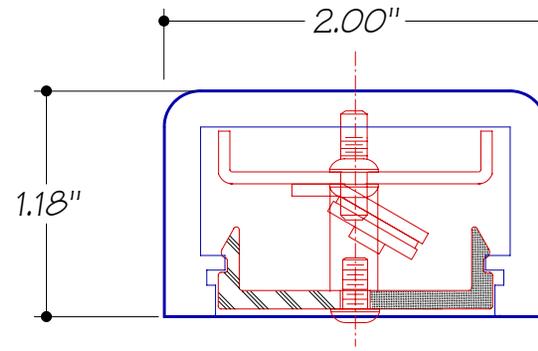
Available colors	Black (BLK)	White (WHT)	RAL:
	Bronze (BRZ)	Silver (SLV)	CUS:



LED wall luminaires - directed				
	LED	A	B	C
24374	ADA 12.3W	11 7/8"	4 3/8"	3 3/8"

TYPE LE400

AUERBACH · GLASOW

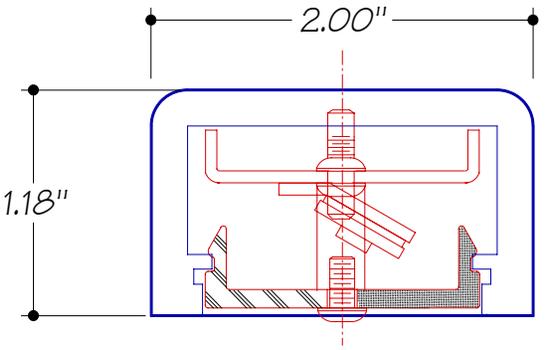


CROSS SECTION

NEW LIGHTRAIL ASYM-30 DEG.

EXTRUDED ALUMINUM / POWER COAT BLACK
EXTRUDED ACRYLIC LENS / HALF CLEAR & HALF BLACK

COLE LIGHTING SINCE 1911	C.W. COLE & CO., INC. 2560 N. ROSEMEAD BLVD., SOUTH EL MONTE, CA 91733-1593 • www.colelighting.com • (626) 443-2473 • FAX (626) 443-9253				
	NEW RECTANGULAR LED LIGHTRAIL				
	JOB: WAYNE STATE UNIV. - DETROIT				
	DRAWN BY DTW	DATE 1-22-19	CHECKED BY D.W.	DATE 1-22-19	SCALE FULL



CROSS SECTION
 NEW LIGHTRAIL ASYM-30 DEG.

EXTRUDED ALUMINUM / POWER COAT BLACK
 EXTRUDED ACRYLIC LENS / HALF CLEAR & HALF BLACK

COLE LIGHTING SINCE 1911	C.W. COLE & CO., INC. 2560 N. ROSEMEAD BLVD., SOUTH EL MONTE, CA 91733-1593 • www.colelighting.com • (626) 443-2473 • FAX (626) 443-9253					
	NEW RECTANGULAR LED LIGHTRAIL					
	JOB: WAYNE STATE UNIV. - DETROIT					
	DRAWN BY DTW	DATE 1-22-19	CHECKED BY D.W.	DATE 1-22-19	SCALE FULL	DRAWING No A2219-LR-WSU

Application

LED bollard with shielded 180° light distribution. This luminaire is designed to provide one sided illumination of ground surfaces. Provided with mounting system that allows the luminaire to be adjusted independent of anchor bolt orientation.

Materials

Luminaire housing and base constructed of die-cast and extruded marine grade, copper free (≤0.3% copper content) A360.0 aluminum alloy
 Borosilicate glass lens
 Reflector made of pure anodized aluminum
 High temperature silicone gasket
 Mechanically captive stainless steel fastener

NRTL listed to North American Standards, suitable for wet locations
 Protection class IP65
 Weight: 19.0lbs

Electrical

Operating voltage 120-277VAC
 Minimum start temperature -20° C
 LED module wattage 7.2W
 System wattage 10.0W
 Controllability 0-10V dimmable
 Color rendering index Ra > 80
 Luminaire lumens 411 lumens (3000K)
 Lifetime at Ta = 15° C 77,000 h (L70)
 Lifetime at Ta = 55° C 53,000 h (L70)

LED color temperature

- 4000K - Product number + **K4**
- 3500K - Product number + **K35**
- 3000K - Product number + **K3**
- 2700K - Product number + **K27**

BEGA can supply you with suitable LED replacement modules for up to 20 years after the purchase of LED luminaires - see website for details

Finish

All BEGA standard finishes are matte, textured polyester powder coat with minimum 3 mil thickness.

Available colors Black (BLK) White (WHT) RAL:
 Bronze (BRZ) Silver (SLV) CUS:



LED bollard · 180° distribution				
	LED	A	B	Anchorage
77 753	7.2W	6 1/2	39 3/8	79 817



Type:
 BEGA Product:
 Project:
 Modified:

SECTION 270513 COMMUNICATIONS SERVICES

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 DESCRIPTION

- A. This section includes the complete interior and exterior technology systems as indicated on the drawings or as specified herein. Provide materials, labor, equipment and supervision to install technology systems.
- B. Codes and standards determine requirements. Contract documents and manufacturer warrantee requirements that exceed the codes and standards are the responsibility of the installing contractor.

1.3 QUALITY ASSURANCE

- A. Technology work shall be in accordance with the following codes and agencies. Refer to the most recent adopted version.
 - 1. National Electrical Code (ANSI/NFPA 70).
 - 2. National Electrical Safety Code (ANSI C-2).
 - 3. Life Safety Code (NFPA 101).
 - 4. Occupation Safety and Health Administration (OSHA).
 - 5. State and Municipal ordinances.
 - 6. Americans with Disabilities Act (ADA).
 - 7. International Building Code (IBC).
- B. Material and Installation Standards: Provide new material and conform to the standards where such have been established for the particular material and installation in question. Publications and Standards of the organization listed below are applicable to materials and installation specified herein. Refer to the most recent adopted version.
 - 1. American Society for Testing and Materials (ASTM)
 - 2. Underwriters' Laboratories, Inc. (UL)
 - 3. National Electrical Manufacturer Association (NEMA)
 - 4. Insulated Cable Engineers Association (ICEA)
 - 5. Institute of Electrical and Electronic Engineers (IEEE)
 - 6. National Fire Protection Association (NFPA)
 - 7. American National Standards Institute (ANSI)
 - 8. Electrical Testing Laboratory (ETL)
 - 9. Edison Electric Institute (EEI)
 - 10. National Board of Fire Underwriters (NBFU)
 - 11. International Standards Organization (ISO)
 - 12. Federal Communications Commission (FCC)
 - 13. ANSI/TIA/EIA-526 – Standard Test Procedures for Fiber Optic Systems.
 - 14. TIA/EIA-526-7-A – Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fiber-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-mode Attenuation and Optical Return Loss Measurement.
 - 15. TIA/EIA-526-14-C – Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; Modification of IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedure - Part 4-1: Installed cable plant - Multimode attenuation measurement.
 - 16. ANSI/TIA-568.0-D – Generic Telecommunications Cabling for Customer Premises.
 - 17. ANSI/TIA-568.1-D – Commercial Building Telecommunications Cabling Standard Part 1: General Requirements.
 - 18. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standards.

19. ANSI/TIA-568.3-D – Optical Fiber Cabling Components Standard.
 20. ANSI/TIA-568.4-D – Broadband Coaxial Cabling and Components Standard.
 21. ANSI/TIA/EIA-569-D – Telecommunications Pathways and Spaces.
 22. ANSI/TIA/EIA-570-C – Residential Telecommunications Infrastructure Standard.
 23. ANSI/TIA/EIA-598-D – Optical Fiber Cable Color Coding.
 24. ANSI/TIA/EIA-606-B – Administration Standard for the Commercial Telecommunications Infrastructure.
 25. ANSI/TIA-607-C – Commercial Building Grounding (Earthing) and Bonding for Telecommunications.
 26. ANSI/TIA/EIA-758-B – Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
 27. ANSI/TIA-942-A – Telecommunications Infrastructure Standard for Data Centers.
 28. ANSI/TIA-1152 – Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling.
 29. ANSI/NECA/BICSI 568 Standard for Installing Commercial Building Telecommunications Cabling.
- C. Installation Methodology: Conform to the publications where such have been established for the particular installation in question. Publications of the organization listed below are applicable to the installation specified herein. Refer to the most recent adopted version.
1. BICSI – Telecommunications Distribution Methods Manual.
 2. BICSI – Customer Owned Outside Plant Design Manual.
- D. Definition of Terms
1. Refer to individual sections
 2. Newton’s Telecom Dictionary

1.4 CONTRACTOR QUALIFICATIONS

- A. A minimum of 5 years’ experience in the installation and service of voice/data cabling communications systems on projects of comparable size and scope.
- B. A minimum of 5 years’ experience in the installation and service of Outside Plant Cabling Systems on projects of comparable size and scope.
- C. Registered with the equipment manufacturer(s) as franchised reseller of registered systems and serve as the installing contractor and ongoing registered service provider.
- D. Registered Communications Distribution Designer (RCDD) certified by the Building Industry Consulting Service International (BICSI).
- E. Installation personnel trained in the proper installation of extended performance data and voice cable, prior to installation, by outside training course or in-house training program.
- F. Installation personnel trained in the proper installation of outside plant cabling, prior to installation, by outside training course or in-house training program.

1.5 PERMITS

- A. Secure and pay for licenses and permits required by the State and Municipality before work is started. Observe requirements of permits and licenses.
- B. Schedule inspection of work and installations by the authority having jurisdiction.

1.6 SUPERVISION

- A. Installations shall be made by persons licensed and skilled in the trade and shall be done under the supervision of a BICSI Registered Communications Distribution Designer (RCDD).

1.7 WARRANTY

- A. Refer to the General Conditions and individual sections, for warranty of work under Division 27.
- B. Warrant to the owner and Architect the following:

1. Materials and equipment furnished under the Contract will be of good quality and new unless otherwise required or permitted by the Contract Documents.
2. The Work will be free from defects not inherent in the quality required or permitted.
3. The Work will conform to the requirements of the Contract Documents.
4. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective.
5. Warranty excludes remedy for damage or defect caused by abuse, modifications not executed under this Contract, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage.
6. If required by the Architect, furnish satisfactory evidence as to the kind and quality of materials and equipment.

1.8 DRAWINGS

- A. The Technology drawings indicate the arrangements of technology 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 technology equipment with structural system and mechanical equipment and access thereto.
- B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans and details unless indicated on Technology plans.
- C. Bring 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.

1.9 SUBMITTALS

- A. Pre-Construction
 1. List of Materials and Subcontractors:
 - a. Refer to Division 1 for submittal requirements.
 2. Schedule of Values:
 - a. Refer to Division 1 for submittal requirements.
 - b. Provide a schedule of values for the technology contract work specified under Division 27. Include separate labor and material itemization for each line item requested.
 - c. Provide the following line items as a minimum level of itemization:
 - 1) Mounting elements in Telecommunications Rooms, Equipment Rooms and Entrance Facilities.
 - 2) Copper Backbone Cabling.
 - 3) Fiber Backbone Cabling.
 - 4) Horizontal Cabling.
 - 5) Network Equipment.
 - 6) Outside Plant Cabling.
 - d. The itemized schedule of values, above, will be used to determine project completion and progress for payment requests, including overhead and profit for each itemization. Schedule of values must be submitted and approved prior to first pay request.
 3. Shop Drawings and Product Data:
 - a. Submit for review, shop drawings and product data of materials and equipment to be incorporated in the work. Support submittals with descriptive material, catalog cut sheets, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements. Provide complete electrical characteristics for equipment.
 - b. Refer to the individual sections for identified equipment and materials for which submittals are required.
 - c. Refer to the SHOP DRAWINGS, PRODUCT DATA AND SAMPLES section for required procedures.
 - d. Neatly bound in a three ring or comb type binder, with protective covers. Identify the project, the site, system, date and vendor name on the cover

- e. Consisting of, but not be limited to the following items:
 - 1) Title sheet showing the Project Name, Project Location, Specification Title and Specification number, Contractor's name, address, phone number, BICSI RCDD registration stamp with signature and date submitted. Provide clear area on the title sheet for shop drawing review stamps.
 - 2) Organize submittal into logical sections and provide table of contents.
 - 3) Material list showing quantity, manufacturer and description of each item being furnished.
 - 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.
- f. Submit documents as a single package per site.
- g. Submit within 2 weeks after award of contract.
- h. The Contractor must neither order equipment nor proceed with installation until the Architect approves shop drawings.

B. Close-Out

- 1. Record Documents:
 - a. Refer to Division 01 for record documents and related submittals.
- 2. Operation and Maintenance Data and Instructions
 - a. Refer to Division 01 for detail requirements.
 - b. Printed Material: Provide required printed material for binding in operation and maintenance manuals.
 - c. Instructions of Owner Personnel:
 - 1) Schedule training with owner.
 - 2) Notify architect 2 weeks prior to training.
 - 3) Provide a competent representative to instruct Owner's designated personnel in systems under this division of the specifications before final inspection, as designated by the Architect. For equipment requiring seasonal operation, perform instructions for other season within six months unless requested otherwise.
 - 4) Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
 - 5) Refer to the individual section for training specific to each system.
 - 6) Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.
 - 7) The owner reserves the right to videotape training.
 - d. Document extent of training to include dates, times, location and attendance roster. Submit for inclusion in Operations and Maintenance Manual.

- C. Refer to Section 018113 "Sustainable Design Requirements" for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

1.10 SITE INVESTIGATION

- A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions that 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.

1.11 COORDINATION

- A. Coordinate entrance facility arrangement with the local exchange carriers and Cable TV service provider.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Materials shall be new.
- B. Furnish materials specified herein or indicated on the drawings.
- C. Materials of the same type shall be the products of one manufacturer.
- D. UL listed material shall bear UL label. ETL listed material shall bear ETL label. ETL label shall be accepted in lieu of UL when the UL testing standards have been followed.
- E. Work such as painting, patching, welding or carpentry related to the work of this Division shall be performed by the appropriate trade experienced in that work, but shall be provided for under this Division.

2.2 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.3 SPARE PARTS

- A. Prior to the final inspection and at the time designed by the Architect, turn over to the Owner spare parts consisting of the following materials in the quantity specified. Materials shall be new, in the original packing, of the same manufacturer and type as installed on the project and comply with these specifications receive receipt for all materials turned over to Owner.
- B. Submit copy of spare parts receipt to the architect.

PART 3 EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

- A. Inspect materials upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material. Handle materials in accordance with manufacturer's applicable standards and supplier's recommendations, and in a manner to prevent damage to materials. Store packed materials in original undamaged condition with manufacturer's labels and seals intact. Containers, which are broken, opened, damaged, or watermarked are unacceptable and shall be removed from the premises.
- B. Material shall be stored in an enclosed, dry building or trailer. Provide areas for general storage. Provide temperature and/or humidity controls where applicable. Equipment stored other than as specified above shall be removed from the premises.
- C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

3.2 EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.3 FIRESTOPPING

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Section 078400 "Firestopping."

3.4 DEMOLITION

- A. Protect existing equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- B. Reroute cabling as required to serve equipment not in the demolition area.
- C. Accessible Work: Remove exposed equipment and installations, indicated to be demolished, in their entirety.
- D. Abandoned Work: Cut and remove buried cabling, indicated to be abandoned.
- E. Remove demolished material from Project site.
- F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- G. Remove devices on wall or ceilings being removed. Coordinate with other divisions.
- H. Assume that existing equipment indicated to be reused is in good working condition and can be installed without repairs. Notify the Architect of items found to be in need of repair or in unusable condition for direction or decision. Repair any damage to equipment caused in removal or handling.
- I. Clean equipment removed and to be re-used before reinstallation.
- J. Carefully remove and deliver to the owner or store where directed on the site, material and equipment noted or required by the owner to be salvaged and which is not scheduled to be reused or relocated.

3.5 REFINISHING AND 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.
- B. Where plywood backboards are provided under Division 27 to mount equipment, paint backboards.
- C. Do not paint trim covers for flush mounted cabinets, unless required by the Architect. Remove trim covers before painting. Under no conditions shall locks or exposed trim clamps be painted.

3.6 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.
- C. Clean accessible elements with compressed air (less than 15 PSI) and vacuum clean the interior of enclosures.
- D. Periodically remove waste and rubbish from project site and maintain order. Premises shall be left clean and free of debris and unused construction materials prior to owner acceptance.

3.7 SERVICE OUTAGES

- A. Technology work requiring interruption of telecommunications service, which would adversely affect the normal operation of the other portions of the Owner's property, shall be done at a time other than normal working hours. Normal working hours shall be considered 8:00 a.m. to 5:00 p.m., Monday through Friday.
- B. Schedule work requiring interruption of telecommunications service two weeks prior to actual shutdown. Submit schedule in writing indicating extent of system to be interrupted, date and time when interruption is intended to occur, and date and time service will be restored. Schedule shall be subject to the approval of the Architect and the Representative of the Owner.
- C. Cancellation: The Owner reserves the right to cancel or change the scheduling of any outage up to 24 hours before its approved starting time. There shall be no additional cost to Owner for scheduled outages, or for outages re-scheduled at the Owner's request where at least 24 hours notice has been given by the Owner.

3.8 CUTTING AND PATCHING

- A. Do not endanger the stability of the structure by cutting, drilling or otherwise modifying the structural members of the building. Direct all requests for structural modifications to the Architect for approval. Proceed with these modifications only as directed by the Architect.
- B. Cutting and patching requirements will be modified only if General Construction Specifications and drawings specifically state that certain portions or all cutting and patching required for each of the various trades is to be performed by the General Contractor.
- C. Refer to General Construction Specifications for execution and requirements for patching and painting and comply with applicable provisions as to materials and quality of installation.
- D. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit installations. Perform cutting by skilled mechanics of trades involved.
- E. 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.

3.9 TECHNOLOGY SYSTEMS OPERATIONAL TESTS, MANUFACTURERS SYSTEMS CERTIFICATION AND DESIGN AUTHORITY ASSISTANCE

- A. Testing:
 - 1. Refer to the individual specification sections for test requirements.
 - 2. Prior to the final inspection, the systems or equipment shall be tested and reported as therein specified. Five (5) typewritten copies of the tests shall be submitted to the Architect for approval.
 - 3. Test technology systems for compliance with the specifications.
- B. Manufacturer's Certifications:
 - 1. Submit the technology systems design documentation for review by a representative of the manufacturer to verify compliance with the manufacturers recommendations and system operation. The manufacturer shall submit certification that the system has been reviewed and the design is in accordance with the manufacturer's recommendations.
 - 2. Submit the technology systems installation and operation for review by a representative of the manufacturer to verify compliance with the manufacturers recommendations and system operation. The manufacturer shall submit certification that the system has been reviewed and the installation is in accordance with the manufacturer's recommendations.
 - 3. Provide manufacturers certifications for the following systems:
 - a. Structured Cabling.

C. Design Authority Assistance:

1. Remove equipment covers for inspection of internal cabling.
2. Remove accessible ceilings for inspection of equipment installed above ceilings.
3. Demonstrate operation of equipment and systems.
4. Remove manhole covers, pump manholes dry and provide a ladder for inspection of interior of manholes.
5. Provide authorized representatives of the manufacturers to demonstrate to the compliance with the specifications of the respective systems during or prior to the final inspection at a time designated by the Architect. Refer to the specific specification section for additional testing requirements.
6. Representatives of the following systems are required for demonstrations:
 - a. Structured Cabling

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
 - 3. Chalfant Manufacturing Company.
 - 4. Chatsworth
 - 5. Cooper B-Line, Inc.
 - 6. Enduro Systems, 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:
 - 1. Configuration: Galvanized-steel wire mesh, complying with NEMA VE 1.

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.
 - d. Finish: Electrogalvanized after fabrication, complying with ASTM B 633.
 - 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 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.

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.
- D. ASTM B633 Standard Specification for Electro-deposited Coatings of Zinc on Iron and Steel.
 ASTM B 695-90 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.
- E. ASTM A109 Standard Specification for Steel, Strip, Carbon, Cold-Rolled.
 ASTM A167 Standard Specification for Stainless and heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 ASTM A480/A480M Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 ASTM A568 Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy Hot-Rolled and Cold-Rolled.
 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.
 ASTM A682 Standard Specification for Steel, Strip, High-Carbon, Cold-Rolled, Spring Quality.
 ASTM A879 Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
- F. ASTM B117 Standard Method of Salt Spray (Fog) Testing
 ASTM D610 Standard test Method for Evaluating Degree of Rusting on Painted Steel Surfaces.
 UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.
- 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 as 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.
 6. Non-continuous cable supports shall be Pentair CableCat™ J-Hook series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS, CAT-CM Double J-Hook, CAT100CM, CAT-CM U-Hook, series, CAT200CMLN, CAT300CMLN, AND CAT-CM Retainer, CATRT200CM, CATRT300CM, or approved equal.
- 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.
 4. Acceptable products: Pentair CAT-CM™ U-Hooks CAT200CMLN, CAT300CMLN; CAT-CM roller assemblies CATRL200CM, CATRL300CM, CATWMCM bracket, or approved equal.
- 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

- A. ASTM B633 Standard Specification for Electro-deposited Coatings of Zinc on Iron and Steel.
 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 271000 STRUCTURED 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. The Data Horizontal Cabling System includes:
 - 1. Category 6 cabling channel, permanent link for data.
 - 2. Outdoor rated Category 6 cabling channel, permanent link for outdoor IP security cameras.
- B. The Data Backbone Cabling System includes:
 - 1. Category 3 twisted-pair cabling system.
 - 2. Multimode and singlemode fiber cabling system for data.
- C. Support the following network topologies;
 - 1. ISDN BRI
 - 2. DS-1
 - 3. DS-3
 - 4. Fractional T-1's
 - 5. T-3's
 - 6. Ethernet 10/100/1000Base-TX, 100BASE-FX, 1000Base-LX, 1000Base-SX, and 10GBASE-SR standards.
- D. Includes mounting elements, cabling, connectors, terminal equipment, cable management and identification.
- E. Registered with the manufacturers of the equipment as an installed system that meets industry standards for structured voice and data cabling systems. Manufacturers' warranty for a minimum period of 15 years for proper operation of any communications protocol designed to operate over the specified cabling system.
- F. Documentation of the voice and data cabling system record.
- G. Tested and documented for reference by the Owner.
- H. Related Sections:
 - 1. Section 270513 – Communications Services.

1.3 EXISTING CONDITIONS

- A. Remove abandoned cables located within the confines of the project back to the source including:
 - 1. Existing cables no longer utilized or tagged for future applications.
 - 2. Cables abandoned within the scope of this project.

1.4 SUBMITTALS

- A. Pre Construction:
 - 1. Qualification of bidders. In addition to the requirements of Division 01, at the request of the owner.
 - a. Provide 3 project references of comparable size and scope that have been completed within the last 2 years. Include: project name, address, date of substantial completion, and name and telephone number of system manager.
 - b. Provide a description of the projects including number of telecommunication rooms, type/category of cabling, number of voice/data horizontal cables and number of backbone pairs/strands.

B. Shop Drawings/ and Product Data:

1. Provide certificates of training for Voice and Data premise cabling, per ANSI/TIA/EIA 568, for supervisors of installation personnel. Certificates shall be acceptable from a manufacturer of the equipment listed or an independent training company.
2. Include a letter describing training program.
3. Certificates indicating franchising of registered cabling systems.
4. Consisting of, but not be limited to the following items:
 - a. Title sheet showing the Project Name, Project Location, Specification Title and Specification number, contractor's name, address, phone number, RCDD Registration Stamp with signature and date submitted. Clear area shall be provided on the title sheet for shop drawing review stamps.
 - b. Organize submittal into logical sections and provide table of contents.
 - c. Elevations of racks and terminal blocks.
 - d. Riser diagrams showing distribution equipment and strand/pair counts
 - e. Provide itemized bill of materials indicating all proposed equipment including quantities, model type, and product description.
 - f. Catalog sheets with complete technical data for each item being furnished. On datasheets with multiple products, indicate which product is provided under this project.
 - g. Confirmation that products are registered components for the manufacturer's warranty.
 - h. System labeling schedules.
 - i. 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.

C. As-Built/Record Drawings:

1. Two sets in hard copy format and two sets in electronic Auto CAD format, including bid submittals, revised shop drawing and product data showing:
 - a. Final configuration of the system
 - b. Final layouts of terminal boards, racks and cabinets
 - c. Floor plans showing cable routes and workstation outlet locations with horizontal cable ids.
 - d. Drawings showing copper backbone pair counts for each backbone cable.
 - e. Record of cross-connection configuration.
 - f. Test results of horizontal cables listed by each Telecom. room and horizontal cable id.
 - g. Test results of fiber optic backbone cabling listed by each Telecom. room and fiber optic backbone cable strand.
 2. Hard copy information shall be in type written or printed form in a useful format.
- D. Refer to Section 018113 Sustainable Design Requirements for requirements of sealants, primers, paints, adhesives, caulk, aerosols, and coatings.

1.5 DESCRIPTION

- A. The data cabling system shall be a premises distribution system consisting of horizontal cabling, and backbone cabling for data.
- B. The data cabling system shall support the future installation and connection of the following equipment. (Equipment not in contract.)
 1. Active data equipment at the Racks.
 2. Telephone equipment at the Racks.
 3. Computers at the Workstation Outlets.
 4. Telephones at the Workstation and Wall Telephone Data Outlets.
 5. Wireless Local Area Network.
 6. Video Surveillance Cameras.
- C. Patch Cord installation not in contract.

PART 2 - PRODUCTS

2.1 CABLING SYSTEM

A. General

1. Supply products, defined as part of the twisted pair cabling system configuration, by a single manufacturer and listed cable partner.
2. Supply products, defined as part of the fiber cabling system configuration, by a single manufacturer and listed cable partner.

B. Twisted Pair and Fiber Optic Cabling Manufacturers:

1. AFL.
2. Belden Wire & Cable Company.
3. Berk-Tek, Inc.
4. CommScope, Inc.
5. Corning Cable Systems.
6. Draka Molex
7. General Cable.
8. HellermannTyton
9. Hitachi Cable Manchester, Inc.
10. Hubbell Premise Wiring.
11. Leviton Telecommunications
12. Mohawk/CDT.
13. Optical Cable Corp (OCC).
14. Optical Fiber Solutions (OFS)
15. Ortronics
16. Panduit Network Connectivity Group.
17. Seltec (110 backboards)
18. Siemon Company.
19. Superior Essex
20. Sumitomo Electric
21. Systimax
22. TE Connectivity

C. Twisted Pair and Fiber Connection Hardware

1. Workstation Outlets:

a. Wall

- 1) Single jack or multiple jacks as indicated on drawings.
- 2) Single gang faceplate with a minimum of four jack mounting openings and blanks to close unused openings.
- 3) Faceplate: Plastic.
- 4) Color for plastic faceplates: As selected by Architect unless indicated otherwise.
- 5) Labeling: White background designation strips with clear plastic covers integral to faceplate.
- 6) Mounting: Outlet box. Flush, in finished areas unless otherwise indicated, surface in unfinished areas.

b. Surface raceway.

- 1) Single jack or multiple jacks as indicated on drawings.
- 2) Single gang faceplate with a minimum of four jack mounting openings and blanks to close unused openings.
- 3) Faceplate: Plastic.
- 4) Color for plastic faceplates: As selected by Architect unless indicated otherwise.
- 5) Labeling: White background designation strips with clear plastic covers integral to faceplate.
- 6) Mounting: Flush in surface raceway.

c. Furniture.

- 1) Single jack or multiple jacks as indicated on drawings.
- 2) Modular furniture adapter to match furniture manufacturer.

- 3) Labeling: White background designation strips with clear plastic covers integral to faceplate
- 4) Mounting: Flush in modular furniture.
- d. Ceiling.
 - 1) Single jack.
 - 2) Single gang faceplate.
 - 3) Faceplate: Stainless steel.
 - 4) Labeling: White background designation strips with clear plastic covers integral to faceplate.
 - 5) Mounting: Outlet box. Flush, in finished areas unless otherwise indicated, surface in unfinished areas.
- e. Wireless LAN Access Point.
 - 1) Single jack or multiple jacks as indicated on drawings.
 - 2) Integral plastic base plate and cover.
 - 3) Labeling: Vinyl adhesive tape.
 - 4) Color: White.
 - 5) Mounting: Surface on structure above accessible ceiling tiles.
- 2. Card Access Control System Controller Panels:
 - a. 12" coil of UTP cable inside of Controller Panel housing terminated with 8-position modular plug. Coordinate specific termination location with Security Contractor.
 - b. Labeling: Vinyl adhesive tape.
 - c. Refer to the Security Plans for Controller locations.
- 3. Video Surveillance Camera Outlets:
 - a. Wall or Ceiling
 - 1) 12" coil of UTP cable inside outlet box terminated with 8-position modular plug.
 - 2) Labeling: White background designation strips affixed to inside surface of outlet box.
 - 3) Mounting: Outlet box. Flush, in finished areas unless otherwise indicated, surface in unfinished areas.
 - 4) Refer to the E4xx series Electrical Systems drawings for locations and additional information.
- 4. Floor Box Outlets.
 - a. Single jack or multiple jacks as indicated on drawings.
 - b. Mount in service plate integral to floor box.
 - c. Service plate and jack arrangement with adequate clearances to comply with TIA/EIA industry standards for maintaining proper bend radii on UTP horizontal cables behind jacks.
 - d. Labeling: Vinyl adhesive tape
- 5. Poke-Thru Outlets.
 - a. Multiple jacks.
 - b. Mount in service plate integral to poke-thru.
- 6. Voice Wall Data Outlets:
 - a. Single jack.
 - b. Mount in single gang faceplate.
 - c. Faceplate: Plastic with mounting posts for wall mount telephone.
 - d. Color for plastic faceplates: As selected by Architect unless indicated otherwise.
 - e. Mounting: Flush, in finished areas unless indicated otherwise, surface in unfinished areas.

D. Twisted Pair Connection Hardware

- 1. Cross-Connect 110 Panel: Modular array of IDC terminal blocks arranged to terminate cables and permit interconnection between cables. Quantity, size and arrangement of panels as indicated on drawings.
 - a. IDC type terminal, using modules designed for punch-down caps or tools.
 - b. IDC Terminal Block Modules: Integral with connector bodies, including plugs and jacks.
 - c. Modular array of IDC 110 terminal blocks.
 - d. Arrange to terminate building cables and permit interconnection between cables
 - e. Number of Terminals: One for each conductor in assigned cables.
 - f. Five pair connecting blocks for backbone cabling.
 - g. Labeling: White background and clear plastic covers integral to the cross connect panel.
 - h. Mounting: Backboard unless indicated otherwise.

2. Cross-Connect 110 Cable Management
 - a. 2 rack position mounting height.
 - b. Color: White.
 - c. Mounting: Backboard unless indicated otherwise.
 - d. Number of cable management units: As indicated on drawings.
 3. Cross-Connect 110 Backboard
 - a. Modular sheet metal or composite material units designed to support 110 terminal blocks and 110 cable management.
 - b. Mounting: Backboard.
 4. Preconfigured Twisted Pair Patch Panel:
 - a. IDC type, using modules designed for punch-down caps or tools.
 - b. Modular panels housing multiple numbered jack units.
 - c. Number of panels: As indicated on drawings.
 - d. Number of ports: As indicated on drawings.
 - e. Number of Jacks: One per port.
 - f. Labeling: White background designation strips with clear plastic covers integral to patch panel.
 - g. Rear horizontal cable management.
 - h. Mounting: Equipment Rack.
 5. Data Jacks:
 - a. 8 position modular
 - b. RJ-45 receptacle units with integral IDC-type terminals.
 - c. Category 6.
 - d. Non-keyed.
 - e. Colors:
 - 1) Match faceplate color as selected by Architect.
 - 2) Preconfigured Twisted Pair Patch Panel: Black.
- E. Fiber-Optic Connection Hardware
1. Patch Panel:
 - a. 6 Modular Connector Panel locations per patch panel and blanks to close unused Connector Panel locations, unless indicated otherwise.
 - b. Minimum height: 2 rack position mounting height, unless indicated otherwise.
 - c. Number of panels: As indicated on drawings.
 - d. Labeling: White background designation strips with clear plastic covers integral to patch panel.
 - e. Clear polycarbonate-tinted, front hinged door.
 - f. Mounting: Equipment Rack.
 2. Modular Connector Panel:
 - a. Housing multiple-numbered duplex-LC cable connector couplers with self-centering, axial alignment mechanisms.
 - b. 6 duplex-LC fiber connectors per Modular Connector Panel.
 - c. Coupler Housing Colors:
 - 1) 50/125 um laser optimized multimode fiber – Aqua
 - 2) Singlemode fiber – Blue
 - d. Provide adequate modular panels to terminate the cables indicated on drawings.
 3. Multimode Cable Connectors:
 - a. Quick connect.
 - b. Insertion loss not more than 0.5 dB.
 - c. Reflectance/Return loss: OM3 and OM4 -35 dB minimum.
 - d. Type: LC.
 - e. Type of fiber termination and end face polishing: Mechanical crimp-on/Factory polished or Fusion splice-on/Factory polished.
 - f. Provide adequate cable connectors to terminate the cables indicated on the drawings.
 4. Singlemode Cable Connectors:
 - a. Quick connect.
 - b. Insertion loss not more than 0.5 dB.
 - c. Reflectance/Return loss:
 - 1) UPC -50 dB minimum.

- 2) APC -60 dB minimum.
 - d. Type: LC.
 - e. Type of fiber termination and end face polishing: Mechanical crimp-on/Factory polished or Fusion splice-on/Factory polished.
 - f. Provide adequate cable connectors to terminate the cables indicated on the drawings.
 - 5. Splices:
 - a. Fusion.
 - b. Insertion loss: not more than 0.3 dB.
 - c. Provide splices at locations indicated on drawings.
 - 6. Splice Cabinet:
 - a. Modular cabinet housing multiple splice trays.
 - b. 8 splice tray locations per cabinet.
 - c. Capability for 12 fusion splices per splice tray.
 - d. Provide adequate modular cabinets and splice trays for the splices indicated.
 - e. Mounting: Wall.
- F. Twisted-Pair Cables
1. UTP Horizontal Cable:
 - a. Data.
 - 1) Category 6.
 - 2) Four thermoplastic-insulated, individually twisted pairs of conductors.
 - 3) Center pair isolating separator.
 - 4) 23-24 AWG, color-coded.
 - 5) Jacket colors: Blue.
 - 6) Plenum rated.
 - b. Outdoor IP Security Cameras:
 - 1) Category 6.
 - 2) Four thermoplastic-insulated, individually twisted pairs of conductors.
 - 3) 23-24 AWG, color-coded.
 - 4) Flooding compound.
 - 5) UV Sunlight resistant jacket.
 - 6) Minimum operating temperature range: -40 C to +70 C.
 2. Twisted-pair Backbone Cable:
 - a. Category 3.
 - b. Multi-pair. Pair counts as indicated on drawings.
 - c. Thermoplastic-insulated, individually twisted pairs of conductors.
 - d. 24 AWG.
 - e. Jacket color: Gray or white.
 - f. Plenum rated.
 3. UTP Data Patch Panel Patch Cords:
 - a. Four-pair cables
 - b. RJ-45 plug at each end.
 - c. Non-keyed plugs.
 - d. Category 6.
 - e. Strain relief boots.
 - f. Jacket color: Blue.
 - g. T568B termination
 4. UTP Data Workstation Patch Cords:
 - a. Four-pair cables.
 - b. RJ-45 plug at each end.
 - c. Non-keyed plugs.
 - d. Category 6.
 - e. Strain relief boots.
 - f. Jacket color: Blue.
 - g. T568B termination
- G. FIBER-OPTIC CABLES
1. Indoor Cables
 - a. 50/125 μ m Multi-Mode laser optimized TIA 492AAAC (OM3)

- 1) 50.0/125 μm diameter tight-buffered optical fiber.
- 2) Fiber counts as indicated on drawings.
- 3) Dual window, 850 nm and 1300 nm.
- 4) Minimum Overfilled Launch Bandwidth –1500 MHz-km at 850 nm, 500 MHz-km at 1300 nm.
- 5) Minimum Laser Launch Bandwidth – 2000 MHz-km at 850 nm, 500 MHz-km at 1300 nm.
- 6) Maximum attenuation – 3.5 dB/km at 850 nm, 1.5 dB/km at 1300.
- 7) Listed types: OFNP.
- b. Singlemode Low Water Peak TIA 492CAAB (OS2):
 - 1) 8.7 to 10 μm diameter tight-buffered optical fiber.
 - 2) Fiber counts as indicated on drawings.
 - 3) Dual window, 1310 nm and 1550 nm.
 - 4) Maximum attenuation – 1.0 dB/km at 1310, 1.0 dB/km at 1550 nm.
 - 5) Listed types: OFNP.
- c. Hybrid:
 - 1) Combination multimode and singlemode cables within a single jacket.
 - 2) Fiber counts as indicated on drawings.
 - 3) Listed Types: OFNP, OFNR, and OFN as it applied for the space installed.
- d. Armored
 - 1) Hybrid, Multimode, Singlemode within a single interlocked armor jacket.
 - 2) Fiber counts as indicated on drawings.
 - 3) Listed Types: OFCP.
2. Fiber Optic Cable Patch Cords:
 - a. 50/125 μm Multimode laser optimized:
 - 1) Dual 50/125 μm fibers.
 - 2) Strain relief boots.
 - b. Single mode:
 - 1) Dual 8.7/125 μm fibers.
 - 2) Strain relief boots.

2.2 MOUNTING ELEMENTS

A. Manufacturers

1. Cabling Systems Manufacturers list above.
2. APW – Wrightline.
3. Arnco (Raceway)
4. B-Line (Cable Support)
5. Carlon (Raceway)
6. Chatsworth.
7. Cope (cable support)
8. ENDOT (raceway)
9. Erico (Cable Support)
10. Ortronics.
11. Panduit Network Connectivity Group.
12. PFT.
13. Rittal

B. Two Post Equipment Racks

1. Freestanding.
2. Modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
3. Approximate Module Dimensions: 84 inches high by 22 inches wide unless noted otherwise.
4. Rails tapped with #12-24 screw threads at EIA-310-D alternating hole pattern/spacing.
5. 19" equipment mounting width.
6. Adjustable shelves.
7. Finish: Baked-polyester powder coat.
8. Color: Black.
9. Number of Equipment Racks: As indicated on drawings.

C. Equipment Cabinets

1. Free standing.
2. Modular-steel units designed for telecommunications equipment support and coordinated with dimensions of units to be supported.
3. Approximate external Cabinet Dimensions: 84 inches high by 30 inches wide by 42 inches deep.
4. Front and rear rails with square holes at EIA-310-D alternating hole pattern/spacing with capability of using cage nuts to adapt square holes to M6, 10-32, or 12-24 mounting screws.
5. 19 inch equipment mounting width.
6. Minimum of 36 inch equipment mounting depth.
7. Front and rear perforated metal doors for increased ventilation and fitted with keyed locks.
8. Integrated vertical cable management front and rear.
9. Finish: Baked-polyester powder coat.
10. Color: Black.
11. Number of Equipment Cabinets: As indicated on drawings.

D. Equipment Cabinets (Wall Mount)

1. Wall Mount.
2. Modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
3. Approximate Module Dimensions 36 inches high by 24 inches wide by 24 inches deep.
4. Rails tapped with #12-24 screw threads at EIA-310-D alternating hole pattern/spacing.
5. 19" equipment mounting width.
6. Finish: Baked-polyester powder coat.
7. Color: Black.
8. Lockable covers.
9. Ventilation kit.

E. Two Post Equipment Rack Cable Management

1. Front and rear vertical:
 - a. 6" and 10" width.
 - b. Hinged front and rear covers.
 - c. Full height of rack.
 - d. Color: Black
 - e. 6" width located at the end of each row of racks and 10" width between each rack as indicated on drawings.
 - f. Number of cable management units: As indicated on drawings.
2. Front horizontal:
 - a. One rack position (1-3/4"), two rack position (3-1/2") and four rack position (7") heights as indicated on drawings.
 - b. Hinged front and rear covers.
 - c. Color: Black
 - d. Horizontal cable management at the top of each rack as indicated on drawings.
 - e. Horizontal cable management adjacent to each product requiring termination as indicated on drawings.

F. Plywood Backboard:

1. 3/4" Class A-D exterior grade plywood.
2. Painted with two coats of marine gray, fire retardant enamel.
3. Height and width of board, as indicated on drawings.

G. Non-metallic optical-fiber raceway: Ribbed duct with pull string shall meet fire ratings CMP.

H. Cable Support.

1. J-Hooks.
2. D Rings.
3. Support Sling
4. Cable Tray (Inside Telecom Rooms)
 - a. Type: Telco Style Ladder Racking.
 - b. Material and Finish: High tensile tubular steel with black powder coat finish.

- c. Width: As indicated on drawings.
 - d. Cross-Rung Spacing: 9".
 - e. Minimum Fitting Radius: 33".
 - f. 3" bend radius cable drop outs.
 - g. NEMA Load/Span Class: 8A.
 - h. Copper bonding conductors for each section and fitting of the cable tray system.
 - i. Fittings and accessories.
- I. General-purpose non-metallic split duct.
- 1. Color: Black
 - 2. Size: As necessary for the quantity of cables enclosed.

2.3 GROUNDING

- A. Manufacturers
- 1. B-Line
 - 2. Chatsworth.
 - 3. Electricmotion Company Inc.
 - 4. Erico
 - 5. Harger Lightning Protection Inc.
 - 6. Lyncole Industries

2.4 IDENTIFICATION PRODUCTS

- A. Cable Markers: Vinyl wraparound adhesive tape markers, machine printed with black lettering on white background.
- B. ½" wide vinyl adhesive tape machine printed with 3/8" high black lettering on white background.

2.5 CABLE MANAGEMENT DATA

- A. The Contractor must provide cable management files. The files shall be windows compatible either spreadsheet or data base format. The files shall identify:
- 1. Workstation cable id.
 - 2. Cable type and tested performance.
 - 3. Time history of; connection, testing, traffic, faults, etc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cable. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CABLE TRAY INSTALLATION

- A. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.
- B. Remove burrs and sharp edges from cable trays.
- C. Fasten cable tray supports to building structure and install seismic restraints.
- 1. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details according to Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
 - 2. Place supports so that spans do not exceed maximum spans on schedules.

3. 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.
 4. Support bus assembly to prevent twisting from eccentric loading.
 5. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
 6. Locate and install supports according to NEMA VE 1.
- D. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA VE 1. Space connectors and set gaps according to applicable standard.
- E. Make changes in direction and elevation using standard fittings.
- F. Make cable tray connections using standard fittings.

3.3 INSTALLATION

- A. Outlet configuration
1. Provide 1 data jack at each workstation data outlet unless noted otherwise.
 2. Provide 1 data jack at each ceiling workstation data outlet unless noted otherwise.
 3. Provide 1 data jack at each floor box data outlet unless noted otherwise.
 4. Provide 1 data jack at each poke-thru data outlet unless noted otherwise.
 5. Provide 1 data jack at each telephone wall outlet unless noted otherwise.
 6. Provide 1 data jack at each Wireless LAN access point data outlet unless noted otherwise.
 7. Provide 1 data jack at each Access Control Panel outlet location. Coordinate exact requirements with Security System supplier.
 8. Provide 1 data jack at each Video Surveillance Security Camera outlet unless noted otherwise. Coordinate exact requirements with Security System supplier.
 9. Provide 2 data jacks for VoIP dialer connection to main Fire Alarm Control Panel. Coordinate exact requirements with Fire Alarm System supplier.
 10. Provide 2 data jacks at each Temperature Control Panel outlet location unless noted otherwise. Coordinate exact requirements with Controls contractor.
 11. Provide 2 data jacks at each network Lighting Control Panel outlet location unless noted otherwise. Coordinate exact requirements with Controls contractor.
- B. Jack terminations:
1. Terminate jacks to the T568B pin/pair assignment, unless noted otherwise.
 2. Termination of jacks for copper backbone: One pair per jack pins 4 and 5 active.
- C. Raceways, boxes, and cable trays
1. Install cables in raceway and cable tray. Provide hanger hardware for pathways not indicated with raceway or cable tray.
 2. Install wall workstation outlets in outlet boxes.
 3. Install floor box workstation outlets in floor boxes.
 4. Install surface raceway workstation outlets in surface raceway.
 5. Install ceiling workstation outlet in outlet boxes.
 6. Install voice wall outlets in outlet boxes.
 7. Raceway, boxes, floor boxes, and cable tray outside of Telecom. Rooms provided by Division 26.
 8. Where conduits contain sealing fittings to prevent the passage of gases from one space to another, fill the sealing fittings with UL-listed sealing compound after the cables are installed.
- D. Cabling
1. Provide continuous lengths of horizontal cable from patch panel termination to jack termination without splices.
 2. Provide continuous lengths of copper twisted pair backbone cable from patch panel jack termination to patch panel jack termination without splices.
 3. Provide continuous lengths of fiber optic cable from patch panel termination to patch panel termination without splices.
 4. Conceal cabling except in unfinished spaces.

5. Terminate cabling at both ends.
 6. Install cable without damaging conductors, shield, or jacket.
 7. Do not bend cable in handling or in installing to smaller radii than minimums recommended.
 8. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
 - a. Pull cables simultaneously if more than one is being installed in the same raceway.
 - b. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - c. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage media or raceway.
 9. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
 10. Secure and support cable at intervals not exceeding 48 inches and not more than 6 inches from cabinets, boxes, outlets, racks and terminal equipment.
 11. Cabling within telecom spaces and enclosures: Provide adequate length of conductors. Train cables to terminal points. Provide tie wraps and lacing to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommendations.
 12. Make terminations only at indicated outlets and terminal equipment.
- E. Grounding
1. Ground equipment racks and cable tray to Telecommunications Grounding Busbar.
 2. Install a copper bonding jumper from each section or fitting of the cable tray system to the next section or fitting of the cable tray system.
 3. Bond cable shields, screens and drain conductors to Telecommunications Grounding Busbar.
 4. Telecommunications Grounding Busbar: In Equipment Room, Telecom Rooms and service entrance by Division 26.
 5. Telecommunications Grounding Backbone Cable: By Division 26.
- F. Equipment Rooms and Telecom Rooms
1. Mount connectors and terminal equipment hardware on backboards, and racks unless otherwise indicated.
 2. Group connecting hardware for cables into separate logical fields as indicated on drawings.
 3. Use patch panels for to terminate cables entering the space, unless otherwise indicated.
 4. Provide supporting connections from racks to structural ceiling or adjacent wall. Anchor rack bases to structural floor.
- G. Non-metallic optical-fiber raceway
1. Provide for non-armored fiber optic cable installations
 2. Provide for armored fiber optic cable installations in conduit, unless noted otherwise.
- H. Terminate jacks and furnish patch cords to the T568B pin/pair assignment, unless noted otherwise.
- I. Comply with EIA/TIA-569 rules for separating unshielded copper communication and data-processing equipment cables from potential EMI sources, including electrical power lines and equipment.
- J. Provide cover plates for outlet boxes including outlets in modular furniture. Provide blank plates for boxes that are indicated on the plans but are not indicated to receive outlet faceplates and jacks.
- K. Provide weatherproof cover for all workstation outlets indicated as weatherproof.
- L. Install furniture workstation outlet in owner furnished modular furniture.
- M. Provide conduit sleeves through penetrations of fire rated walls and floor/ceiling penetrations.
- N. Provide service plate and faceplate for mounting of jacks in floor boxes. Floor boxes provided by Division 26.
- O. General-purpose non-metallic split duct.
1. Provide for horizontal cable installation from floorbox service fitting to systems furniture. Systems furniture by owner.

3.4 PATCH CABLES

- A. Furnish the following patch cables for installation by owner.

1. UTP Data Patch Panel Patch Cords:
 - a. Quantities to patch 110% of terminated Patch Panel Data Jacks.
 - b. Lengths:
 - 1) 10% at 2' length.
 - 2) 20% at 3' length.
 - 3) 30% at 4' length.
 - 4) 30% at 6' length.
 - 5) 10% at 8' length.
 2. UTP Data Workstation Patch Cords:
 - a. Quantities to patch 110% of terminated Workstation Data Jacks.
 - b. Lengths:
 - 1) 50% at 6' length.
 - 2) 50% at 10' length.
 3. Fiber Optic 50/125 μ m Multimode Patch Cords (LC to LC):
 - a. Duplex LC optical fiber connectors on both ends.
 - b. Quantities to patch 50% of terminated 50/125 μ m Multimode fibers at both ends.
 - c. Lengths:
 - 1) 10% at 3' length.
 - 2) 30% at 6' length.
 - 3) 10% at 9' length.
 4. Fiber Optic Singlemode Patch Cords (LC to LC):
 - a. Duplex LC optical fiber connectors on both ends.
 - b. Quantities to patch 50% of terminated Singlemode fibers at both ends.
 - c. Lengths:
 - 1) 10% at 3' length.
 - 2) 30% at 6' length.
 - 3) 10% at 9' length.
- B. Telecommunications Rooms:
1. Post 1/2 size floors plans for the areas served. Indicate the workstations jack location with faceplate cable id labels on plan. Provide in rigid frames and clear plastic covers.
- C. Label the cabling system components, mounting elements, grounding products and power components.

3.5 CLEANING AND REPAIRS

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.
- B. If the Cabling Contractor fails to complete their work in coordination with the General Contractor, the Cabling Contractor will be responsible for all cleaning, patching, painting, replacement of damaged ceiling tiles or any other damage that their installers cause to the finished area. No additional compensation will be permitted because of a failure to properly coordinate the installation with the General Contractor.

3.6 CABLE TESTING

- A. Voice and Data Horizontal Cables:
 1. Test 100% of data, UTP horizontal cables for performance to TIA/EIA-568-C.2, category 6, permanent link requirements. The test instrument shall conform to the TIA/EIA-1152 Level III, measurement accuracy.
 2. Replace and retest any cable that fail to pass the performance requirements.
 3. Record the results of each test with cable identification and provide as part of as-built drawings and cable management software.
- B. Twisted Pair Backbone Cables:
 1. Test 100% of backbone copper cable pairs for: continuity, shorts between conductors, reversed pairs, split pairs, and transposed pairs.

2. Rereminate and retest any pair that fails. Replace the backbone cable if the total number of failed pairs in the cable exceeds 2% of the total number of pairs in the cable. Label bad pairs that fail after reremination and retesting if the total number of failed pairs in the cable does not exceed 2% of the total number of pairs in the cable.
 3. Record the results of each test with cable pair identification and provide as part of as-built drawings and cable management software.
- C. Intra-Building Fiber Optic Backbone Cables:
1. Test 100% of backbone fiber strands with an Optical Power Meter and Lightsource to ensure the fiber strands meet or exceed the cable performance requirements of TIA/EIA-568-C.3.
 2. Test multimode backbone links in at least one direction at both operating wavelengths of 850 nm and 1300 nm in accordance with TIA/EIA-526-14-C, Annex A, One Cord Reference Method. The tester shall be encircled flux compliant. The Channel loss shall be 2.5 dB or less for each fiber strand.
 3. Test singlemode backbone links in at least one direction at both operating wavelengths of 1310 nm and 1500 nm in accordance with TIA/EIA-526-7-A, Annex A, One Cord Reference Method. The Channel loss shall be 1.5 dB or less for each fiber strand.
 4. Replace and retest any cables with fiber strand(s) that fail to pass the performance requirements.
 5. Record the results of each test with cable identification and provide as part of record drawings and cable management software.
- D. Inter-Building (Campus) Fiber Optic Backbone Cables:
1. Test 100% of backbone fiber strands with an OTDR (Optical Time Domain Reflectometer) to ensure the fiber strands meet or exceed the cable performance requirements of TIA/EIA-568-C.3. The test set-up shall include both the Launch cable and the Tail cable.
 2. Test OM3 and OM4 multimode backbone links in both directions at both operating wavelengths of 850 nm and 1300 nm in accordance with TIA/EIA-526-14-C, Annex D. The reflectance shall be -35 dB or greater for each fiber strand.
 3. Test singlemode backbone links in both directions at both operating wavelengths of 1310 nm and 1500 nm in accordance with TIA/EIA-526-7-A, Annex D. The reflectance shall be -50 dB or greater for each fiber strand terminated with UPC connectors and -60 dB or greater for each fiber strand terminated with APC connectors.
 4. Replace and retest any cables with fiber strand(s) that fail to pass the performance requirements.
 5. Record the results of each test with cable identification and provide as part of record drawings and cable management software.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to review the following with the Owner's maintenance personnel.
1. Labeling system and cross-reference to documentation.
 2. Interpretation of cable test results.
 3. Review data in maintenance manuals.
 4. Warranty procedures.
- B. Schedule training with Owner, through Architect, with at least seven days advance notice. Owner training to include, but not be limited to the following:
1. Final walk-thru of all Telecom. Spaces.
 2. Review of hard copy and electronic as-built drawings indicating workstation outlet locations and cable ids.
 3. Review of hard copy and electronic as-built drawings indicating copper backbone house pair counts.
 4. Review of cable test data.

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.
 - 2. "Architect" is the Architect for the project: Hamilton Anderson Associates.
 - 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. 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
3. The following Contractors have submitted the required qualifications and have been approved to bid:
 - a. Hairel Enterprises
3708 Hilltop Dr
Conroe, TX 77303
Contact: Robert Slaughter
Phone: 936-539-1135
Email: rslaughter@hesound.com
 - b. LD Systems
407 Garden Oaks Blvd
Houston, TX 77018
Contact: Tony Kelly
Phone: 713-695-9400
Email: tkelly@ldsystems.com
 - c. Masque Sound
21 East Union Ave.
East Rutherford, NJ 07073
Contact: Jeanne Wu
Phone: 201-939-8666
Email: jeannewu@masquesound.com
 - d. North American Theatrix
60 Industrial Dr.
Southington, CT 06489
Contact: Gary Peck
Phone: 860-863-4112
Email: gpeck@natheatrix.com
 - e. Onyx Audio Visual
800 Principal Ct., Suite A
Chesapeake, VA 23320
Contact: Tom Beaudry
Phone: 757-436-6116
Email: tbeaudry@onyxav.com
 - f. Professional Audio Designs
11707-B West Dearbourn Ave.
Wauwatosa, WI 53226
Contact: Kim Leonard
Phone: 414-476-1011
Email: kim@proaudiodesigns.com
 - g. Sound Associates
979 Saw Mill River Road
Yonkers, NY 10710
Contact: Phillip Peglow
Phone: 914-963-3452
Email: ppeglow@soundassociates.com.com

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
 - b. Part 22: Public mobile services.
 - c. Part 24: Personal communications services.
 - d. Part 25: Satellite communications.
 - 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
 - b. ANSI A14.7-2000: Safety Requirements for Mobile Ladder Stands and Mobile Work Platforms.
 - c. ANSI C2-2002: National Electrical Safety Code
 - d. ANSI Z136.1-2000: Safe Use of Lasers and laser systems
 - e. ANSI Z136.2-1997: Safe Use of Optical Fiber
 - f. ANSI Z359.1-1992 (R1999): Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.
 - 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
 - p. ANSI A10.42-2000: Rigging Qualifications and Responsibilities
 6. Applicable Performance Standards – Execute all Division work in accordance with the following standards:
 - a. ANSI S4.48-1992 (R1998): Recommended Practice for the Application of Connectors, Part 1, XLR-Type polarity, and gender
 - 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

- d. ANSI S12.2-1995 (R1999): Criteria for Evaluating Room Noise
- e. ANSI T1.217-1991 (R1998): Integrated Services Digital Network (ISDN) Management –Primary Rate Physical Layer
- 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
- ee. ANSI/TIA/EIA-526-7 Measurement of Optical Power Loss of Installed Single mode Fiber Cable Plant
- ff. ANSI/IEEE C-2 National Electrical Safety Code how to install cabling in accordance with the most recent edition of BICSI® publications:
- gg. BICSI Telecommunications Distribution Methods Manual
- hh. BICSI Cabling Installation Manual

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

ITEMS TO BE PROVIDED AND INSTALLED	General Contractor		Electrical Contractor		Systems Contractor	
	Provide	Install	Provide	Install	Provide	Install
Main Power Service Panel Boards and Circuit Breakers			X	X		
• Main Power Service Conduit and Conductors			X	X		
• Main Power Service Terminations				X		
Audio & Video Technical Power (AVTP) Transformers			X	X		
• Transformer Conduit and Conductors			X	X		
• Transformer Terminations				X		
AVTP Isolated Ground Conduit and Conductors			X	X		
• Isolated Ground Terminations				X		
AVTP Distribution Panelboards and Circuit Breakers			X	X		
• Distribution Panelboard Conduit and Conductors			X	X		
• Distribution Panelboard Terminations				X		
AVTP Standard Load Centers and Circuit Breakers			X	X		
• Standard Load Center Conduit and Conductors			X	X		
• Standard Load Center Terminations				X		
AVTP Company Switches for Portable Equipment			X	X		
• Company Switch Conduit and Conductors			X	X		
• Company Switch Terminations				X		
AVTP Outlet Devices for Branch Circuits delivered to Systems Equipment Racks and Devices					X	X
• Equipment Rack Back Boxes and Wall Plates					X	X
• Outlet Device Back Boxes			X	X		
• Outlet Device Wall Plates			X	X		
• Branch Circuit Conduit and Conductors			X	X		
• Branch Circuit Termination				X		
Systems Equipment Racks and Devices					X	X
• Metallic Conduit between Systems Devices and Racks			X	X		
• Insulation Bushings between Metallic Conduit Racks			X	X		
• Systems Equipment Rack Cabling					X	X
• Systems Equipment Rack Terminations						X
Systems Device Back Boxes and Floor Boxes				X	X	

• Systems Device Metallic Conduit			x	x◇		
• Systems Device Cabling					x	x
• Systems Device Termination						x
Empty Conduit (for temporary use)			x	x		
• Systems Cable Trays			x	x		
• Systems Cable Sleeves			x	x		
• Systems Pull Boxes			x	x		
Conduit Riser Diagram Submittal			x◇			

◇ 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:
 1. Giddings, Philip. Audio Systems Design and Installation.

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):

	Wiring Type
Group A	Microphones and other sensitive wiring (0 mV to 100 mV)
Group B	Line level wiring (100 mV to 10 V)
Group C	Loudspeaker and control wiring (10 V to 70 V)
Group D	Telephone, video, control and digital circuits
Group E	Category Cable, and Fiber optic cable
Group F	Spare Conduit

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:

	Group A	Group B	Group C	Group D	Group E
Group A	adjacent	6"	12"	12"	12"
Group B	-	adjacent	12"	6"	6"
Group C	-	-	adjacent	6"	6"
Group D	-	-	-	adjacent	adjacent
Group E	-	-	-	-	adjacent
Group F	12"	12"	12"	12"	12"

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:

	Group A	Group B	Group C	Group D	Group E	Group F
Dimmer controlled lighting	24"	12"	6"	12"	12"	24"
SCR controlled services	24"	12"	6"	12"	12"	24"
220/440V circuits	6"	6"	adjacent	adjacent	adjacent	24"
All other services	6"	6"	adjacent	adjacent	adjacent	24"

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

- Review and coordinate electrical power system installation including grounding with the electrical contractor to ensure proper operation of the Systems.
- 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.
- 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

- 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

- 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.
- 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.
- 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.
- Clean all box interiors before installing plates, panels or covers.
- 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 Entelec 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 dismantled 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 0.1 μ F 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 dismantled 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 alphanumeric 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.

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.
 - 6. Surface pathways.
 - 7. Boxes, enclosures, and cabinets.
 - 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.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 3. Anamet Electrical, Inc.
 - 4. Bridgeport Fittings, Inc.
 - 5. Electri-Flex Company.
 - 6. O-Z/Gedney; a brand of EGS Electrical Group.
 - 7. Picoma Industries; Subsidiary of Mueller Water Products, Inc.
 - 8. Republic Conduit.
 - 9. Robroy Industries
 - 10. Southwire Company.
 - 11. Thomas & Betts Corporation.
 - 12. Western Tube and Conduit Corporation.
 - 13. Wheatland Tube Company; a division of John Maneely Company.
- 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 race-way type to another must be UL listed for that application.
- l. 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.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 3. Anamet Electrical, Inc.
 - 4. Arnco Corporation.
 - 5. CANTEX Inc.
 - 6. CertainTeed Corp.
 - 7. Condux International, Inc.
 - 8. Electri-Flex Company.
 - 9. Kraloy.
 - 10. Lamson & Sessions; Carlon Electrical Products.
 - 11. Niedax-Kleinhuis USA, Inc.
 - 12. RACO; a Hubbell Company.
 - 13. Thomas & Betts Corporation.
- 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.
 4. Erickson Electrical Equipment Company.
 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.
 11. O-Z/Gedney; a brand of EGS Electrical Group.
 12. RACO; a Hubbell Company.
 13. Robroy Industries.
 14. Spring City Electrical Manufacturing Company.
 15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
 16. Thomas & Betts Corporation.
 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 CABLING

- 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.
 - c. CDR Systems Corporation; Hubbell Power Systems.
 - 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.
 - c. CDR Systems Corporation; Hubbell Power Systems.
 - 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 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 coordinated 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 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.
- 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 design. 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 installation. Contact the architect of design where discrepancies and/or conflicts occur with ceiling finishes, décor and other discipline construction documents. Concealable notification device product 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 addition to the Hilberry Theatre, as shown on the drawings and specified herein. The system shall include, 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 equipment 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 building fire alarm devices and emergency voice control equipment, and a Fire Alarm Network Reporting 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 Terminal. All interface equipment provisions, equipment connections, software integration, equipment support, and site coordination shall be the responsibility of the Fire Alarm Contractor.
 - 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 system 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.

Location	Interface Terminals
Security Equipment Closets	Automatic Unlock
Fire Command Center	Manual Unlock
	Manual Unlock Switch Position
	Auxiliary Monitoring (Alarm and Trouble)

- 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 is 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 is 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.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Air-sampling smoke detectors.
 - 5. Heat detectors.
 - 6. Notification appliances.
 - 7. Device guards.
 - 8. Magnetic door holders.
 - 9. Remote annunciator.
 - 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.
 - a. Notification Appliance Circuits (NAC): 25% spare capacity for each circuit installed.
 - 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	A	B	C	D	E	F	G	I	J	K	M	N
Spot type smoke detector	X ₁	X ₁	X ₁	X	-	X	X	-	-	-	-	X
Spot type heat detector	X ₁	X ₁	X ₁	X	-	-	X	-	-	-	-	X
Spot type smoke detector at elevator lobby and/or elevator equipment rooms	X ₁	X ₁	X ₁	X	-	X	X	-	X	X	-	X
Heat detector – elevator equipment room or elevator pit	X ₁	X ₁	X ₁	X	-	-	X	-	X	X	-	X
Smoke detector for door release function	X ₁	X ₁	X ₁	X	-	X	X	X	-	-	-	X
Duct smoke detector – mechanical equipment fan	X ₂	X ₂	X ₂	-	-	X	-	-	-	-	-	X
Duct smoke detector – damper	X ₂	X ₂	X ₂	-	X	X	-	-	-	-	-	X
Div. 21 wet sprinkler water flow switches	X ₁	X ₁	X ₁	X	-	-	X	X	-	-	-	X
Div. 21 sprinkler valve tamper	X ₂	X ₂	X ₂	-	-	-	-	-	-	-	-	X
Post indicator valve (PIV) tamper switch	X ₂	X ₂	X ₂	-	-	-	-	-	-	-	-	X
Air-sampling smoke detector panel output – pre-alarm	X ₂	X ₂	X ₂	-	-	-	-	-	-	-	-	-
Air-sampling smoke detector panel output – alarm	X ₁	X ₁	X ₁	-	-	X	X	-	-	-	-	-
Control panel ac power loss	X ₃	X ₃	X ₃	-	-	-	-	-	-	-	-	X
Class “A” network wire fault	X ₃	X ₃	X ₃	-	-	-	-	-	-	-	-	X
Communication network fault	X ₃	X ₃	X ₃	-	-	-	-	-	-	-	-	X
Communication fault digital communicator	X ₃	X ₃	X ₃	-	-	-	-	-	-	-	-	X
Fire alarm battery or charger failure	X ₂	X ₂	X ₂	-	-	-	-	-	-	-	-	X
User disabling of zones or individual devices	X ₂	X ₂	X ₂	-	-	-	-	-	-	-	-	X
Open circuits, shorts, and grounds in designated circuits.	X ₃	X ₃	X ₃	-	-	-	-	-	-	-	-	X
Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.	X ₂	X ₂	X ₂	-	-	-	-	-	-	-	-	X
Loss of communication with any addressable device	X ₃	X ₃	X ₃	-	-	-	-	-	-	-	-	X
Ground or a single break in internal circuits of fire-alarm control panel	X ₂	X ₂	X ₂	-	-	-	-	-	-	-	-	X
Abnormal ac voltage at fire-alarm control panel	X ₂	X ₂	X ₂	-	-	-	-	-	-	-	-	X
Break in standby battery circuitry	X ₂	X ₂	X ₂	-	-	-	-	-	-	-	-	X
Abnormal position of any switch at fire-alarm control panel or annunciator	X ₃	X ₃	X ₃	-	-	-	-	-	-	-	-	X
Common alarm signal	X	X	X	X	-	-	-	-	-	-	X	X
Common supervisory signal	X	X	*	-	-	-	-	-	-	-	-	X
Common trouble signal	X	X	*	-	-	-	-	-	-	-	-	X
Initiating Device	A	B	C	D	E	F	G	I	J	K	M	N

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
 - 2. Siemens Industry, Inc.; Fire Safety Division.
 - 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-Appliance, and Signaling-Line Circuits:
 - 1. Pathway Class Designations: NFPA 72, Class A.
 - 2. Pathway Survivability: Level 1.
 - 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.
 - 1. Batteries: Sealed lead calcium.
- 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
 - 2. Siemens Industry, Inc.; Fire Safety Division.
 - 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
 - 2. Siemens Industry, Inc.; Fire Safety Division.
 - 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. 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.
- 6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Notifier, Inc., a Honeywell company
 - 2. Siemens Industry, Inc.; Fire Safety Division.
 - 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.
 - 3. Siemens Industry, Inc.; Fire Safety Division.
 - 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 a 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.
 - 4. Strobe Leads: Factory connected to screw terminals.
 - 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.
 6. Mounting: semi-recessed.
 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 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.
 4. Manual test report function and manual transmission clear indication.
 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.
 8. Communication bus failure.
- 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 equivalent²⁰

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 NPFA.
 - 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.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.
 - 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. 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.

- K. 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.
- L. 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.
- M. 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.
- N. 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.
- O. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- P. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
- Q. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor
- R. Provide addressable monitor modules with 120V relays for each smoke damper connection to provide individual programmed control of damper(s).
- S. Provide addressable monitor modules for elevator controller to initiate elevator recall.
- T. Provide addressable monitor modules for elevator circuit breaker shunt-trip for power shutdown.
- U. Provide addressable monitor modules for AHU for power shutdown. The shutdown relay shall be located adjacent to the controller for the AHU.
- V. Provide 2-input or 10-input addressable monitor modules when applicable.
- W. 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.
 - 6. Supervisory connections at elevator shunt-trip breaker.
 - 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.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 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.
 - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per the "Testing 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



WAYNE STATE UNIVERSITY

Gateway Theater Complex

WSU No. 189-178578 | HAA No. 2016034.00

Project Manual

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100% Design Development

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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 berming 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

- A. 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.
 - 4. Moisture-density relationship 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 Retain paragraph and subparagraphs below if rock is anticipated, blasting is permitted, and independent oversight is required. Revise reporting requirements to suit Project.
 - 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).
 - 7. GW (well-graded gravel).
- 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.

3.18 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.

3.19 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.

3.20 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.
- C. Regulatory Requirements: Comply with (MDOT) Michigan Department of Transportation's current Standard Specification for Construction for asphalt paving work.

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 specification section 32 1415 "Pavement Marking".

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

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
 - 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.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface Variation: Gap below 10-foot- long, unlevelled 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 321316
DECORATIVE CONCRETE PAVING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes colored concrete paving.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of exposed color, pattern, or texture indicated.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative concrete paving systems.
- B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups of decorative concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches (2400 mm) by 96 inches (2400 mm).

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

2.3 STEEL REINFORCEMENT

- A. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, fabricated from as-drawn steel wire into flat sheets.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
- C. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars; assembled with clips.

- D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

2.4 CONCRETE MATERIALS

- A. Cementitious Materials:
 - 1. Portland Cement: ASTM C 150/C 150M, gray portland cement Type I/II.
- B. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.
 - 1. Maximum Coarse-Aggregate Size: 1 inch (25 mm nominal).
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Air-Entraining Admixture: ASTM C 260/C 260M.
- D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
- E. Color Pigment: ASTM C 979/C 979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable nonfading, and resistant to lime and other alkalis.
- F. Water: Potable and complying with ASTM C 94/C 94M.

2.5 SURFACE COLORING MATERIALS

- A. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
- B. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type I, Class B, manufactured for colored concrete.
 - 1. For integrally colored concrete, curing compound shall be pigmented type approved by coloring admixture manufacturer.
 - 2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.
- C. Clear Acrylic Sealer: Manufacturer's standard, waterborne, nonyellowing and UV-resistant, membrane-forming, medium-gloss, acrylic copolymer emulsion solution, manufactured for colored concrete, containing not less than 15 percent solids by volume.

2.7 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
- B. Polyethylene Film: ASTM D 4397, 1 mil (0.025 mm) thick, clear.

2.8 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M).
- B. Cementitious Materials Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. Air Content: 5-1/2 percent plus or minus 1.5 percent.
- D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
- E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
- F. Concrete Mixtures: Normal-weight concrete.
 - 1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).
 - 2. Maximum W/C Ratio at Point of Placement: 0.45.
 - 3. Slump Limit: 4 inches (100 mm, plus or minus 1 inch (25 mm)).

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Proof-roll prepared subbase surface below decorative concrete paving to identify soft pockets and areas of excess yielding.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

3.4 STEEL REINFORCEMENT INSTALLATION

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness.

3.6 CONCRETE PLACEMENT

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- B. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.
- C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D. Screed paving surface with a straightedge and strike off.
- E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. 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. Refloat surface immediately to uniform granular texture.

3.8 INTEGRALLY COLORED CONCRETE FINISH

- A. Integrally Colored Concrete Finish: After final floating, apply the following finish:
 - 1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3.9 PIGMENTED MINERAL DRY-SHAKE HARDENER APPLICATION

- A. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surfaces according to manufacturer's written instructions and as follows:
 - 1. After final power floating, apply the following finish:
 - a. Retain "Burlap Finish," "Medium-to-Fine-Textured Broom Finish," or "Medium-to-Coarse-Textured Broom Finish" Subparagraph below or revise to suit Project.
 - b. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
 - c. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
 - d. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.
- B. Pigmented Powder Release Agent: Uniformly distribute onto dry-shake-hardened and still-plastic concrete at a rate of 3 to 4 lb/100 sq. ft. (1.5 to 2 kg/10 sq. m).

- C. Liquid Release Agent: Uniformly mist surface of dry-shake-hardened and still-plastic concrete at a rate of 5 gal/1000 sq. ft. (0.2 L/sq. m).

3.10 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. 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 after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Compound: Apply immediately after final finishing. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.
 - 1. Cure integrally colored concrete with a curing compound.

3.11 SEALER APPLICATION

- A. Clear Acrylic Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90 degrees to the direction of the first coat, using same application methods and rates.
 - 1. Begin sealing dry surface no sooner than 14 days after concrete placement.

3.12 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 (ACI 117M).

3.13 REPAIR AND PROTECTION

- A. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

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. Crafcoc 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. Crafcoc 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:
 - a. Crafcoc Inc.; Superseal 444/777.
 - b. Meadows, W. R., Inc.; Poly-Jet 3406.
 - 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.
 - c. Meadows, W. R., Inc.; Sealtight Hi-Spec.
 - 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:
 - 1. Decorative steel fences.
 - 2. Swing gates.
 - 3. Gate operators, including controls.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For fencing and gates.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.
- C. Samples: For each fence material and for each color specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Product test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

PART 2 - PRODUCTS

2.1 DECORATIVE METAL FENCES AND GATES

- A. Product: Montage Plus Ornamental Steel Fencing and Gates
- B. Picket Spacing: Standard (4.675 O.C.)
- C. Bottom rail treatment: Extended
- D. Style: 3 Rail
- E. Color: Black
- F. Manufacturer:
 - 1. Ameristar Fence Products
Tulsa, Oklahoma

2. Or approved equal.

2.2 MATERIALS

- A. Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 psi (310 MPa) and a minimum zinc (hot-dip galvanized) coating weight of 0.60 oz/ft² (184 g/m²), Coating Designation G-60.

2.3 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.

2.4 FABRICATION

- A. Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.
- B. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by Ameristar's proprietary fusion welding process, thus completing the rigid panel assembly.
- C. 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).
- D. 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 DECORATIVE FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.
- B. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches (600 mm) plus 3 inches (75 mm) for each foot (300 mm) or fraction of a foot (300 mm) that fence height exceeds 4 feet (1.2 m).
- 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: Place concrete around **posts** and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 3. Posts Set in Concrete: Extend post to within 6 inches (150 mm) of specified excavation depth, but not closer than 3 inches (75 mm) to bottom of concrete.
 4. Space posts uniformly.

3.2 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

**SECTION 323300
SITE FURNISHINGS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bike Racks.
 - 2. Benches.
 - 3. Tables With Chairs
 - 4. Tables Without Chairs

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. Product: Bola Bike Rack
- B. Manufacturer:
 - 1. Landscape Forms Inc.
431 Lawndale Avenue, Kalamazoo, Michigan 49048
(800) 521-2546
www.landscapeforms.com
- C. Color: Contractor to submit available colors for owner selection
- D. Mounting: Embedded

2.2 GARDEN BENCHES

- A. Manufacturer:
 - 1. Landscape Forms Inc.
431 Lawndale Avenue, Kalamazoo, Michigan 49048
(800) 521-2546
www.landscapeforms.com
- B. Model: Multiplicity Bench
- C. Style: Backless, left mitre, no arms, mitre modified angle as illustrated in drawings.
- D. Color: Contractor to submit available colors for owner selection
- E. Wood: Ipe
- F. Mounting: Surface Mount

2.3 METAL BENCHES

- A. Manufacturer:
 - 1. Landscape Forms Inc.
431 Lawndale Avenue, Kalamazoo, Michigan 49048
(800) 521-2546
www.landscapeforms.com
- B. Model: Plexus II
- C. Color: Contractor to submit available colors for owner selection
- D. Support style: Straight
- E. Seat style: Backed seats
- F. Number of seats on support: Three
- G. Arm options: Arms at end
- H. Table option: No Table
- I. Mounting: Surface Mount

2.4 TABLES WITH SEATS

- A. Manufacturer:
 - 1. Landscape Forms Inc.
431 Lawndale Avenue, Kalamazoo, Michigan 49048
(800) 521-2546
www.landscapeforms.com
- B. Model: Carousel Tables.
- C. Seating: Casual height, three seat unit, and casual height four seat unit.
- D. Seat Style: Backless metal grid.
- E. Tabletop: Catena 30 inch diameter, power coated steel.
- F. Mounting: Surface mounted.

2.5 TABLES WITHOUT SEATS

- A. Manufacturer:
 - 1. Landscape Forms Inc.
431 Lawndale Avenue, Kalamazoo, Michigan 49048
(800) 521-2546
www.landscapeforms.com.
- B. Model: GO Outdoor Table.
- C. Style: Standing height.
- D. Power option: Hardwired power.
- E. Power garage one option: 2-port USB outlet.
- F. Power garage two option: GFCI duplex outlet.
- G. Mounting: Surface mounted.

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

**SECTION 328400
PLANTING IRRIGATION**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Controllers.
 - 2. Pipes, sleeves and fittings.
 - 3. Wire and wire connectors.
 - 4. Manual valves.
 - 5. Automatic control valves.
 - 6. Sprinklers.
 - 7. Bubblers.
 - 8. Drip System.
 - 9. Quick couplers.
 - 10. Boxes for automatic control valves.

1.2 PERFORMANCE REQUIREMENTS

- A. Irrigation zone control shall be automatic operation with multiple two-wire controllers and automatic control valves.
- B. Location of Sprinklers, Bubbler and Drip Systems: 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 areas indicated.
- C. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
 - 1. All irrigation piping whether mainline: Minimum 200 psig.
 - 2. All irrigation polyethylene lateral piping: Minimum 100 psig.
 - 3. Automatic control valves and isolation valves: 200 psig.

1.3 ACTION 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Zoning Chart: Show each irrigation zone and its control valve.
- C. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit operation and maintenance manuals for controllers, automatic control valves, drip irrigation, and quick coupling valves.
- B. Record Drawings: Provide a 30x42" system record of actual construction. Locate irrigation equipment locations with two horizontal dimensions to permanent improvements. In addition to water source, controller and valves, show actual mainline, lateral and wire routings and sleeves.

1.6 SERVICE AND MAINTENANCE

- A. The Contractor shall service the system at the Owner's request during the guarantee period and shall be paid for work performed which is not covered by the guarantee.
- B. After completion, testing and acceptance of the system, the Contractor will instruct the Owner's personnel in the operation and maintenance of the system.

1.7 WARRANTY

- A. Contractor shall ensure and guarantee satisfactory operation of the entire system and the workmanship and restoration of the area. The entire system 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.

PART 2 - PRODUCTS

2.1 CONTROLLERS

- A. As indicated on Drawings.

2.2 PIPES, SLEEVES, AND FITTINGS

- A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
- B. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end.
 - 3. 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.
 - 4. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
 - 5. 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.
- C. PVC Pipe, Pressure Rated: ASTM D 2241, PVC 1120 compound, SDR 21, 200 PSI.
 - 1. PVC Fittings: ASTM D 2466, Schedule 40 suitable for solvent weld, except all threaded PVC pipe fittings shall be ASTM D2467, schedule 80 PVC.
 - 2. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- D. PE Pipe with Controlled ID: ASTM F 771, PE 3408 compound; [SIDR 11.5] [and] [SIDR 15].
 - 1. Insert Fittings for PE Pipe: ASTM D 2609, nylon or propylene plastic with barbed ends. Include bands or other fasteners.

2.3 WIRE AND WIRE CONNECTORS

- A. Two-wire Cable: Type UL Approved, direct burial, size AWG 14, manufactured for use with specified Controllers.
- B. Decoders, surge arrestors and sensors: Manufactured for use with specified Controllers.
- C. Low voltage wire connections to be made using wire nuts and 3M DBR/Y connector, per Controller manufacturer requirements.

- D. 120 Volt or heavier splices made underground are to be made using wire nuts and 3M brand Scotch-Lok.
- E. Ground cable per latest manufacturer's requirements.

2.4 MANUAL VALVES

- A. Nibco T-113 bronze, non-rising stem, threaded gate valve.

2.5 AUTOMATIC CONTROL VALVES

- A. As indicated on Drawings.

2.6 SPRINKLERS

- A. As indicated on Drawings and designed for uniform coverage over entire area indicated at available water pressure.

2.7 BUBBLERS

- A. As indicated on Drawings and designed for uniform coverage over entire area indicated at available water pressure.

2.8 DRIP SYSTEM

- A. Header pipe: Schedule 40 PVC, 1" size.
- B. Dripline: As indicated on Drawings and designed for uniform coverage over entire area indicated at available water pressure.
- C. All associated equipment, including fittings, indicator stake, flush valve, pressure regulating valve, and filters shall be manufactured for use with the dripline manufacturer.

2.9 QUICK COUPLERS

- A. Factory-fabricated, cast brass body with spring-loaded, self-closing, thermoplastic locking covers and 1-inch IPS inlet, as indicated in Drawings.

2.10 BOXES FOR AUTOMATIC CONTROL VALVES

- A. Plastic Boxes: Tapered enclosure of rigid plastic material comprised of fibrous components chemically inert and unaffected by moisture, corrosion and temperature changes, designed for installing flush with grade.
 - 1. Size: As noted on Drawings.
 - 2. Shape: Rectangular
 - 3. Color: Black.
 - 4. Lettering: Marked for Irrigation, branded with valve number.
- B. Drainage Backfill: Cleaned gravel or crushed stone, 3/4 inch.

PART 3 - EXECUTION

3.1 EARTHWORK & PIPING INSTALLATION

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

- B. Install warning tape directly above pressure piping, 12 inches below finished grades, except 6 inches below subgrade under pavement and slabs.
- C. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.
- D. Install plastic pipe in accordance with manufacturer's installation instructions and ASTM D2274, particularly as it applies to thermal expansion and contraction.
- E. Solvent welding shall be in strict accordance with manufacturer's recommendations and ASTM Standards D2564 and D2855, especially as they apply to ambient temperature. Allow glued joints to set at least twenty-four hours before pressure is applied to the system.
- F. All mainline and contiguously pressurized pipe is to be installed using open trench and backfill.
- G. 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").
- H. Install piping in sleeves under parking lots, roadways, and sidewalks prior to paving. Minimum depth to be 24"-30" beneath subgrade.
- I. Where sleeves need to be installed beneath existing paving, open cut paving and repair per paving specifications for this project. Coordinate and pay for paving contractor to do all work associated with removing and repairing paving including the purchasing backfill material and paying paving contractor to backfill after the sleeves have been installed.
- J. 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.
- K. Install sleeves made of SDR 21, 200 PSI, PVC pipe and socket fittings, and solvent-cemented joints.

3.2 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. 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.
 - 3. PVC Nonpressure Piping: Join according to ASTM D 2855.
- F. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners according to piping manufacturer's written instructions.

3.3 VALVE INSTALLATION

- A. Install assembly as indicated in Drawings.
- B. All manual, automatic, and quick coupler valves shall be enclosed in a valve box.
- C. Install valve boxes on a suitable base of gravel to provide a level foundation at proper grade and to provide drainage. Support box with block to protect pipe. Add valve box manufactured extensions as required to prevent soil settlement around the valve. Set box flush with finish grade and aligned parallel with adjacent boxes and/or adjoining sitework. Refer to Drawings.

3.4 SPRINKLER INSTALLATION

- A. Install sprinklers after hydrostatic test is completed.
- B. Install sprinklers at manufacturer's recommended heights and as indicated in Drawings.
- C. Locate part-circle sprinklers to maintain a minimum distance of 4 inches from walls and 2 inches from other boundaries unless otherwise indicated.

3.5 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION

- A. Equipment Mounting: Install interior controllers on wall.
 - 1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Equipment Mounting: Install exterior freestanding controllers on precast concrete bases.
 - 1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Install surge protection and grounding equipment as recommended by Controller manufacturer.
- D. Install control cable in same trench as irrigation piping and beside piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas. Where necessary to run wire in a separate trench, provide a minimum cover of 24"
- E. Install wire with 24" of slack so as to provide for expansion and contraction. Expansion joints in wire may be provided at 200 foot intervals by making 5-6 turns of the wire around a piece of 1/2" pipe.
- 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. Install decoders per manufacturer's recommendations.
- J. Ground controller, cable, and decoders per manufacturer's recommendations.

3.6 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each automatic controller.
 - 1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches. See Section 312000 "Earth Moving" for warning tapes.

3.7 FIELD QUALITY CONTROL

- A. Controllers: 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 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.

3.8 ADJUSTING

- A. Adjust settings of controllers.
- B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.
- C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with finish grade.

END OF SECTION

**SECTION 329113
SOIL PREPARATION**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes planting soils specified by composition of the mixes.

1.2 DEFINITIONS

- A. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- B. Imported Soil: Soil that is transported to Project site for use.
- C. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- D. 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.
- E. 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.
- F. 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.
- G. 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.
- H. USCC: U.S. Composting Council.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each bulk-supplied material in sealed containers labeled with content, source, and date obtained; providing an accurate representation of composition, color, and texture.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, 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.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

- A. Existing Soil: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified as recommended by soil testing agency to produce viable planting soil. Blend existing, on-site surface soil with soil amendments and fertilizers to produce planting soil:
- B. Manufacture Topsoil: Imported, naturally formed soil from off-site sources and consisting of sandy loam soil according to USDA textures; and modified to produce viable planting soil.
 - 1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches (100 mm) deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass.
- C. Manufactured Topsoil: Manufactured soil consisting of manufacturer's basic sandy loam according to USDA textures, blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials to produce viable planting soil.
 - 1. Additional Properties of Manufacturer's Basic Soil before Amending: Soil reaction of pH 6 to 7 and minimum of 4 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
 - 2. Unacceptable Properties: Manufactured soil shall not contain the following:
 - a. Unacceptable Materials: 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.
 - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the manufactured soil.
 - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1-1/2 inches (38 mm) in any dimension.
 - 3. Blend manufacturer's basic soil with soil amendments and fertilizers as recommended by soil testing agency to produce viable planting soil.

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent.
- 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."
- B. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

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.

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.

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 1-1/2 inches (38 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Spread unamended soil to total depth indicated on Drawings, 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 12 inches (300 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 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply manufactured soil on-site in its final, blended condition. 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) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Application: Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
1. Lifts: Apply planting soil in lifts not exceeding 12 inches (300 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 lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698.
- 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.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Soil will be considered defective if it does not pass tests[and inspections].
- C. Prepare test reports.
- D. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.6 PROTECTION AND CLEANING

- 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. 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

**SECTION 329200
TURF AND GRASSES**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sodding.

1.2 DEFINITIONS

- A. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- B. 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 and drawing designations for planting soils.

1.3 INFORMATIONAL SUBMITTALS

- A. Certification of grass seed.
 - 1. Certification of each seed mixture for turfgrass sod.
- B. Product certificates.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
 - 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: Three years' experience in turf 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. Pesticide Applicator: State licensed, commercial.
- B. Warranty: The Contractor shall and hereby does warranty that all work in this section shall be free from defects of materials and workmanship, and that turf areas meet a green uniform standard of appearance, until the Contractor has maintained the turf from substantial completion through three mowings. The Contractor shall correct any imperfect work whenever discovered until termination of warranty obligations. When the work is accepted in part, the warranty periods extend from each partial acceptance to the terminal date of the last warranty period. Thus all turf warranty periods terminate on the same date.
- C. Pesticide Applicator: State licensed, commercial.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other 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, as applicable.

- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

- A. Turfgrass Sod: Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod of grass species as follows, with not less than 85 percent germination, not less than 95 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. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).
 - d. 10 percent redtop (*Agrostis alba*).
 - 3. Shade: Proportioned by weight as follows:
 - a. 50 percent chewings red fescue (*Festuca rubra* variety).
 - b. 35 percent rough bluegrass (*Poa trivialis*).
 - c. 15 percent redtop (*Agrostis alba*).

2.2 FERTILIZERS

- A. 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: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

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.

PART 3 - EXECUTION

3.1 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Reduce elevation of planting soil to allow for soil thickness of sod.

- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 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 soil or sod during installation. Tamp and roll lightly to ensure contact with soil, 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 slopes exceeding 1:3.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (38 mm) below sod.

3.3 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Landscape Maintenance Season: The landscape maintenance season is defined as the months during which landscape maintenance operations are required, and extends from April 1 to October 31 of any given year. When substantial completion occurs after April 1, the season extends from substantial completion through October 31.
- C. Watering: The Contractor shall be responsible for ensuring necessary watering for successful establishment of all lawn areas. Contractor to coordinate with Owner as required to ensure installed irrigation system is providing sufficient amounts of water. During the first week, keep sod pads and seeded areas moist at all times. In the absence of adequate rainfall, perform watering daily or as often as necessary during the first week, and thereafter for another week in sufficient quantities to maintain moist soil to a depth of at least 4". In subsequent weeks, water sod and seed areas as required to maintain adequate moisture in the upper inches of the soil necessary for the promotion of deep root growth. Water prior to the heat of the day to prevent wilting. Watering is required prior to acceptance of the work. Water at the rate necessary to keep installed sod and seed in thriving condition, as defined hereinabove.
- D. Sod Mowing: Mow turf as soon as top growth is tall enough to cut when the sod is firmly rooted and secure in place. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Mowing frequency to be determined by growth rate of sod. Remove no more than one-third 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 1/2" to 2 1/2". All clippings shall be caught and removed from site.

- E. Edging and Trimming: All turf areas adjacent to paving or cultivated areas shall be kept neat and attractive by edging and trimming. Under no circumstances shall the Contractor trim at the base of trees with a "weed-eater" type of trimmer.
- F. Weed Control: Keep sod and seed areas free from weeds. If weeds or other undesirable vegetation threaten to smother the planted sod or seed, spray or drench said vegetation with weed killer, or in the case of rank growth, uproot manually, rake and remove from the site. If weed killer is used, apply per manufacturer's recommendations. Sprinkling shall not resume for a 24 hour period following application, or as manufacturer recommends. Contractor shall notify Owner and Architect of his intent to use weed killer.
- G. Pest Control: Control of pests such as insects or fungus diseases shall be done as required to keep sod and seed areas in a thriving condition with appropriate spray applied by licensed personnel per manufacturer's recommendations. Notify Owner of intent to spray prior to performing this work.
- H. Clean-up: Cleaning operations shall be performed at least daily during and after all maintenance operations, so that the project site is kept in a neat and tidy condition at all times.

3.4 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
 - 1. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.
- C. Acceptance Procedure:
 - 1. Completion of Work: Upon completion of the work, a review will be made by the Architect upon written notice requesting such a review submitted by the Contractor at least ten (10) days in advance of the anticipated date. The purpose of the review shall be to determine whether or not the Contractor has completed all of the work of this contract, including maintenance of all sodded areas.
 - 2. Review for Substantial Completion: This review shall take place at the same time as the maintenance review after a viable stand of turf has been achieved, and after at least one mowing of turf. The Architect will make a review to begin the warranty of turf areas on the date requested, by the Contractor, as above specified, or as soon thereafter as possible. If the work is found to be in compliance with the Contract Documents, the Architect will notify in writing the Contractor and Owner of the beginning of the warranty period. The Contractor shall prepare an initial punch list for the Architect's review, noting any areas of sod or seed not in healthy condition at this time, recommending changes in maintenance procedures and creating a list of replacement areas. Contractor and Architect shall then review the work together on-site.
 - 3. Maintenance Review: Maintenance review and substantial completion review shall take place simultaneously, if possible. If turf areas are found to be defective, make necessary replacements, continue initial maintenance for at least another set of mowings, and request another inspection.
 - 4. Warranty Period: Make periodic inspections during the warranty period to determine what changes should be made to the maintenance program. Submit in writing to the Architect any recommended changes. Upon completion of the warranty period submit a request for a review at least ten (10) days in advance of the anticipated date.
 - 5. Review for Final Acceptance: The Architect will make a review for Final Acceptance of the Contract work, including maintenance but exclusive of replacements. If the work is found to be in compliance, the Architect will recommend acceptance by the Owner, exclusive of replacement turf or wildflowers subject to warranty. If there are any deficiencies in the maintenance, the Contractor will be notified of these deficiencies in writing and the work shall be subject to re-review before acceptance.

END OF SECTION

SECTION 329300 PLANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plants.
 - 2. Landscape edgings.
- B. Related Requirements:
 - 1. Section 329600 "Transplanting" for transplanting non-nursery-grown trees.

1.2 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- C. 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.
- D. 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.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples of each type of mulch.

1.5 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

1.7 QUALITY ASSURANCE

- A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 1. Pesticide Applicator: State licensed, commercial.

- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. Handle planting stock by root ball.
- C. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.
- D. 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.

1.9 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 Substantial Completion.
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: One full planting season.
 - b. Ground Covers, Biennials, Perennials, and Other Plants: One full planting season.

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.
- B. 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.

2.2 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
 - 1. Size: 5-gram tablets.
 - 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

- A. Organic Mulch: Shredded hardwood.

2.4 WEED-CONTROL BARRIERS

- A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101g/sq. m) minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

2.5 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.

2.6 LANDSCAPE EDGINGS

- A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
 - 1. Edging Size: 1/4 inch (6.4 mm) thick by 5 inches (125 mm) deep.
 - 2. Finish: Manufacturer's standard paint.

PART 3 - EXECUTION

3.1 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 and mix planting soil in-place over exposed subgrade or 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.

3.2 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 smeared or smoothed during excavation.
 - 2. Excavate approximately three times as wide as ball diameter.
 - 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

3.3 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. Set each plant plumb and in center of planting pit or trench with root level with adjacent finish grades.
 - 1. Backfill: Planting soil For trees, use excavated soil for backfill.
 - 2. Balled and Burlapped Stock: 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.
- D. Container-Grown Stock: Carefully remove root ball from container without damaging root ball or plant.
 - 1. 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.
 - 2. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
 - 3. Continue backfilling process. Water again after placing and tamping final layer of soil.
- 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.

3.4 TREE, SHRUB, AND VINE PRUNING

- A. 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.
- B. Do not apply pruning paint to wounds.

3.5 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.6 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
 - 1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 3-inch (75-mm) average thickness, with 36-inch (900-mm) radius around trunks or stems. Do not place mulch within 3 inches (75 mm) of trunks or stems.
 - 2. Organic Mulch in Planting Areas: Apply 3-inch (75-mm) average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) of trunks or stems.

3.7 EDGING INSTALLATION

- A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches (760 mm) apart, driven below top elevation of edging.

3.8 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, 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.
- D. 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.
- E. 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.

3.9 MAINTENANCE SERVICE

- A. Maintenance Service: 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 for Trees and Shrubs: One full season from date of Substantial Completion.
 - 2. Maintenance Period for Ground Cover and Other Plants: One full planting season from date of Substantial Completion.

END OF SECTION

SECTION 329600 TRANSPLANTING

GENERAL

1.1 SUMMARY

- A. Section includes transplanting non-nursery-grown trees by tree spade.

1.2 DEFINITIONS

- A. General: See definitions in ANSI A300 (Part 6) and in ANSI Z60.1 pertaining to field-grown trees, except as otherwise defined in this Section.
- B. Caliper: Diameter of a trunk as measured by a diameter tape at a height 6 inches (150 mm) above the root flare for trees up to, and including, 4-inch (100-mm) size at this height; and as measured at a height of 12 inches (300 mm) above the root flare for trees larger than 4-inch (100-mm) size.
- C. Root-Ball Depth: Measured from bottom of trunk flare to the bottom of root ball.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Pruning Schedule: Written schedule prepared by arborist detailing scope and extent of pruning each tree in preparation for and subsequent to transplanting.

1.5 INFORMATIONAL SUBMITTALS

- A. Certification: From arborist, certifying that transplanted trees have been protected during construction and that trees were promptly and properly treated and repaired when damaged.
- B. Maintenance Recommendations: From arborist, recommended procedures to be established by Owner for care and protection of trees after completing the Work.
- C. Existing Conditions: Documentation of existing trees indicated to be transplanted, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
- D. Tree-maintenance reports.

1.6 QUALITY ASSURANCE

- A. Tree-Service Firm Qualifications: An experienced landscaping contractor or tree-moving firm that has successfully completed transplanting work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
 - 1. Arborist Qualifications: Certified Arborist as certified by ISA, licensed arborist in jurisdiction where Project is located, current member of ASCA, or registered Consulting Arborist as designated by ASCA.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. 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 in such a manner as to destroy their natural shape.
- B. Completely cover foliage when transporting trees while they are in foliage.
- C. Handle trees by root ball. Do not drop trees.
- D. Move trees after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after moving, set trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify final grade elevations and final locations of trees and construction contiguous with trees by field measurements before proceeding with transplanting work. Perform transplanting only after finish grades are established.
- B. Seasonal Restrictions: Transplant trees during the following in-season periods:
 - 1. Spring: April 1 to May 30
 - 2. August 1 to October 30

1.9 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Provide tree maintenance by skilled employees of tree-service firm and as required in Part 3. Begin maintenance immediately after preparatory pruning and continue until plantings are healthy and well established but for not less than maintenance period below.
 - 1. Maintenance Period: 12 months from date of transplanting completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Transplanted trees shall be healthy and resume vigorous growth within one year of transplanting without dieback due to defective extracting, handling, planting, maintenance, or other defects in the Work.

2.2 PLANTING MATERIALS

- A. Backfill Soil: Excavated soil mixed with planting soil of suitable moisture content and granular texture for placing and compacting in planting pit around tree, and free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.
 - 1. Mixture: Well-blended mix of two parts excavated soil to one part planting soil.
 - 2. Planting Soil: Planting soil as specified in Section 329113 "Soil Preparation."

2.3 MISCELLANEOUS PRODUCTS

- A. Organic Mulch: Shredded hardwood as specified in Section 329300 "Plants."
- B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- C. Burlap: Non-synthetic, biodegradable.

- D. Pesticides: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended in writing 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.
- E. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
 - 1. Size: 5-gram tablets.
 - 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.
- F. Weed-Control Barriers:
 - 1. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101 g/sq. m) minimum.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning excavation.
- B. Lay out individual transplant locations and areas for multiple plantings, and obtain Architect's acceptance of layout before transplanting.
- C. Apply antidesiccant to trees uniformly, using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during extracting, handling, and transportation.
 - 1. If deciduous trees are moved in full leaf, spray with antidesiccant before extracting and again two weeks after transplanting.
- D. Wrap trees with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during extracting, handling, and transporting.

3.2 PREPARATORY PRUNING

- A. Root Pruning: Perform preparatory root pruning under direction of arborist as far in advance of extracting each tree as the Project Schedule allows.
- B. Crown Pruning (Tip Pruning):
 - 1. Do not perform preparatory crown pruning (tip pruning).
 - 2. Perform preparatory crown pruning as directed by arborist. Follow procedures as specified in "Crown Pruning" Article.

3.3 EXCAVATING PLANTING PITS

- A. General: Excavate under supervision of the arborist. Keep excavations covered or otherwise protected until replanting trees.
- B. Subsoil and topsoil removed from excavations may be used as planting soil.
- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees are encountered in excavations.
- D. Seepage: Notify Architect if subsoil conditions evidence unexpected water seepage into tree-planting pits.

3.4 EXTRACTING TREES

- A. General: Extract trees under supervision of the arborist.
- B. Orientation Marking: Mark the north side of each tree with non-permanent paint before extracting.
- C. Root-Ball Width: Minimum 10 inches (250 mm) of root-ball diameter, or least dimension for non-round root balls, for each inch (25 mm) of tree caliper being transplanted.
 - 1. Out-of-Season Planting: If planting before or after the in-season period for tree, provide a minimum root-ball diameter of 12 inches (305 mm) for each inch (25 mm) of tree caliper being transplanted.
- D. Root-Ball Depth: As determined by the arborist for each species and size of tree and for site conditions at original and planting locations.
- E. Digging:
 - 1. Dig and clear a pit with tree spade to the depth of the root system.
 - 2. Cut exposed roots manually with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not paint or apply sealants on cut root ends.
 - 3. Cover roots with burlap and keep them moist until planted.
- F. Extracting with Tree Spade: Use the same tree spade to extract the tree as will be used to transport and plant the tree.

3.5 PLANTING

- A. Planting Standard: Perform planting according to ANSI A300 (Part 6) unless otherwise indicated.
- B. Before planting, verify that root flare is visible at top of root ball. 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.
- C. Ensure that root flare is visible after planting.
- D. Remove injured roots by cutting cleanly; do not break. Do not paint or apply sealants on cut root ends.
- E. Orientation: Position the tree so that its north side, marked before extracting, is facing north in its new location.
- F. Set tree plumb and in center of planting pit with top of root flare level with adjacent finish grades.
 - 1. Use specified backfill soil for backfill.
 - 2. 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.
 - 3. Redirect exposed root ends downward in backfill areas where possible. Hand-expose roots as required to bend and redirect them without breaking.
 - 4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended by arborist. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
 - 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- G. Planting with Tree Spade: Use the same tree spade for planting as was used to extract and transport the tree.
- H. Slopes: When planting on slopes, set the tree 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 CROWN PRUNING

- A. Prune branches as directed by arborist.
 - 1. Prune to remove only injured, broken, dying, or dead branches. Do not prune for shape.
 - 2. Do not remove or reduce living branches to compensate for root loss caused by cutting root system or to improve natural tree form.
 - 3. Pruning Standards: Perform pruning according to ANSI A300 (Part 1).

3.7 TREE STABILIZATION

- A. Stabilize tree as directed by arborist.

3.8 MULCHING

- A. Organic Mulch: Apply 3-inch (75-mm) average thickness of organic mulch extending 12 inches (300 mm) beyond edge of individual planting pit, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) of trunks or stems.

3.9 TREE MAINTENANCE

- A. Perform tree maintenance as recommended by arborist. Maintain arborist observation of transplanting work.
- B. Maintain trees 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. Treat as required to keep trees free of insects and disease.
- C. Fill areas of soil subsidence with backfill soil. Replenish mulch materials damaged or lost in areas of subsidence.
- D. Apply treatments as required to keep tree materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
- E. Pesticide Application: Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- F. Reports: Have arborist prepare monthly inspection reports.

3.10 REPAIR AND REPLACEMENT

- A. General: Repair or replace transplanted trees and other plants indicated to remain or be relocated that are damaged by construction operations, in a manner recommended by the arborist and approved by Architect.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours according to arborist's written instructions.
 - 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 or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

3.11 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Except for materials indicated to be recycled, remove surplus soil, excess excavated material, waste materials, displaced plants, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

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.
 - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
 - 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.
 - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
 - 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:
 - 1. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
 - 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.
 - 3. Set-screw mechanical retainer glands.
 - 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

SECTION 333100 FACILITY SANITARY SEWERS

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 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 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.

2.5 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.

- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 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.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.6 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.

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 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.
- E. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

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 Polyethelene 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

