Wayne State University
5454 Cass Avenue, Detroit, Michigan 48202

University Services Building
HVAC and Fire Alarm
WSU Project Number 060-313984

FOR BIDS
Project Manual
FTCH Project Number 180756
### Table of Contents

#### Division 00 Bidding and Contracting Requirements *(Provided by Wayne State University)*

- 00 05 00 Information for Bidders
- 00 10 00 Instructions to Bidders
- 00 25 00 Notice of Pre-Bid Conference
- 00 30 00 Form of Proposal & Qualification Statement
- 00 42 00 Project Labor Agreements
- 00 43 00 Payment Package Document Requirements
- 00 50 00 Agreement Between Contractor and Owner for Construction
- 00 51 00 Form of Guarantee
- 00 70 00 General Conditions (AIA A-201)
- 00 80 00 WSU Supplementary General Conditions of the Contract for Construction

#### Division 01 General Requirements *(Provided by Wayne State University)*

- 01 00 00 General Requirements *(Provided by Wayne State University)*
- 01 10 00 Summary of Work (Including Scope of Work) *(Provided by Wayne State University)*
- 01 18 13 Protection, Restoration and Notification
- 01 23 00 Alternates
- 01 25 13 Product Substitution Procedures
- 01 26 13 Requests for Information
- 01 31 13 Project Coordination
- 01 31 19 Project Meetings
- 01 32 16 Construction Progress Schedule
- 01 33 00 Submittal Procedures
- 01 42 00 References
- 01 50 00 Temporary Facilities and Controls
- 01 66 00 Product Storage and Handling Requirements
- 01 71 36 Monitoring of Existing Conditions
- 01 73 29 Cutting and Patching
- 01 74 00 Cleaning and Waste Management
- 01 75 00 Starting and Adjusting
- 01 77 00 Closeout Procedures
- 01 78 39 Project Record Documents

#### Division 02 Existing Conditions

- 02 41 19 Selective Demolition
- 02 42 13 Removal of Existing Equipment

#### Division 03 Concrete

- 03 01 33 Fiber Reinforced Composite Concrete

#### Division 07 Thermal and Moisture Protection

- 07 84 13 Penetration Firestopping
- 07 92 00 Joint Sealants

#### Division 08 Openings

- 08 11 13 Hollow Metal Doors and Frames
- 08 14 16 Flush Wood Doors
- 08 71 11 Door Hardware (Descriptive Specification)
DIVISION 09  FINISHES
09 22 16  Non-Structural Metal Framing
09 29 00  Gypsum Board
09 30 00  Tiling
09 51 00  Acoustical Ceilings
09 65 13  Resilient Base and Accessories
09 65 19  Resilient Tile Flooring
09 68 13  Tile Carpeting
09 91 00  Painting

DIVISION 10  SPECIALTIES
10 14 01  Interior Signage
10 28 00  Toilet and Bath Accessories

DIVISION 12  FURNISHINGS
12 21 13  Horizontal Louver Blinds
12 24 13  Roller Window Shades
12 36 41  Solid-Surface Countertops

DIVISION 22  PLUMBING
22 05 00  General Plumbing Provisions
22 05 03  Steel Pipe and Fittings for Plumbing
22 05 06  Cast Iron Pipe and Fittings for Plumbing
22 05 07  Plastic Pipe and Fittings for Plumbing
22 05 09  Copper Pipe and Fittings for Plumbing
22 05 19  Meters and Gages for Plumbing Piping
22 05 23  General Duty Valves for Plumbing
22 05 29  Hangers and Supports for Plumbing Piping and Equipment
22 05 31  Penetrations for Plumbing
22 05 73  Testing and Cleaning of Plumbing Systems
22 07 19  Plumbing Piping Insulation
22 08 00  Commissioning of Plumbing
22 10 00  Plumbing Piping and Specialties
22 36 00  Domestic Water Heaters
22 40 00  Plumbing Fixtures

DIVISION 23  HEATING, VENTILATING, AND AIR CONDITIONING
23 01 00  Operation and Maintenance of HVAC Systems
23 05 00  General HVAC Provisions
23 05 03  Steel Pipe and Fittings for HVAC
23 05 09  Copper Pipe and Fittings for HVAC
23 05 13  Common Motor Requirement for HVAC Equipment
23 05 23  General Duty Valves for HVAC
23 05 29  Hangers and Supports for HVAC Piping and Equipment
23 05 31  Penetrations for HVAC
23 05 46  Sound and Vibration Control for HVAC
23 05 48  Wind Restraint Controls for HVAC
23 05 76  Vibration Testing of HVAC Systems
23 05 93  Testing, Adjusting and Balancing for HVAC
23 07 13  Duct Insulation
23 07 19  HVAC Piping Insulation
### Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>23 09 00</td>
<td>Instrumentation and Control for HVAC</td>
</tr>
<tr>
<td>23 10 23</td>
<td>Natural Gas Piping System</td>
</tr>
<tr>
<td>23 20 19</td>
<td>Piping Specialties for HVAC</td>
</tr>
<tr>
<td>23 21 13</td>
<td>Hydronic Piping</td>
</tr>
<tr>
<td>23 21 23</td>
<td>Hydronic Pumps</td>
</tr>
<tr>
<td>23 25 00</td>
<td>HVAC Water Treatment</td>
</tr>
<tr>
<td>23 31 13</td>
<td>Metal Ducts</td>
</tr>
<tr>
<td>23 33 13</td>
<td>Dampers</td>
</tr>
<tr>
<td>23 36 00</td>
<td>Air Terminal Units</td>
</tr>
<tr>
<td>23 37 00</td>
<td>Air Outlets and Inlets</td>
</tr>
<tr>
<td>23 40 00</td>
<td>HVAC Air Cleaning Devices</td>
</tr>
<tr>
<td>23 74 43</td>
<td>Packaged, Outdoor Heating and Cooling Units</td>
</tr>
<tr>
<td>23 82 00</td>
<td>Convection Heating Units</td>
</tr>
<tr>
<td>23 83 19</td>
<td>Radiant Ceiling Heating and Cooling Systems</td>
</tr>
</tbody>
</table>

**DIVISION 26**

#### ELECTRICAL

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 05 00</td>
<td>Common Work Results for Electrical</td>
</tr>
<tr>
<td>26 05 20</td>
<td>Conductors and Cables - 600V and Below</td>
</tr>
<tr>
<td>26 05 27</td>
<td>Grounding and Bonding</td>
</tr>
<tr>
<td>26 05 29</td>
<td>Hangers and Supports for Electrical Systems</td>
</tr>
<tr>
<td>26 05 34</td>
<td>Raceways for Electrical Systems</td>
</tr>
<tr>
<td>26 05 35</td>
<td>Boxes for Electrical Systems</td>
</tr>
<tr>
<td>26 05 53</td>
<td>Identification for Electrical Systems</td>
</tr>
<tr>
<td>26 09 23</td>
<td>Lighting Control Devices</td>
</tr>
<tr>
<td>26 24 16</td>
<td>Panelboards</td>
</tr>
<tr>
<td>26 27 26</td>
<td>Wiring Devices</td>
</tr>
<tr>
<td>26 28 00</td>
<td>Low Voltage Circuit Protective Devices</td>
</tr>
<tr>
<td>26 28 20</td>
<td>Enclosed Switches</td>
</tr>
<tr>
<td>26 50 00</td>
<td>Lighting</td>
</tr>
</tbody>
</table>

**DIVISION 27**

#### COMMUNICATIONS

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 10 00</td>
<td>Communications Overview</td>
</tr>
<tr>
<td>27 11 00</td>
<td>Communications Room</td>
</tr>
<tr>
<td>27 16 00</td>
<td>Cat-6 Cabling</td>
</tr>
<tr>
<td>27 72 00</td>
<td>Submittals</td>
</tr>
<tr>
<td>27 76 00</td>
<td>Labeling</td>
</tr>
<tr>
<td>27 77 00</td>
<td>Testing</td>
</tr>
<tr>
<td>27 77 50</td>
<td>Training</td>
</tr>
<tr>
<td>27 77 80</td>
<td>Warranty</td>
</tr>
</tbody>
</table>

**DIVISION 28**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 31 00</td>
<td>Fire Detection and Alarm</td>
</tr>
</tbody>
</table>

**END OF TABLE OF CONTENTS**
SECTION 01 18 13 – PROTECTION, RESTORATION AND NOTIFICATION

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 responsibilities for the protection, restoration and notification requirements for surface and subsurface structures, underground facilities and surface improvements.

1.3 NOTIFICATION AND INTERRUPTIONS

A. Prior to Start of Construction:
   1. Notify MISS DIG at least 72 hours in advance at 1-800-482-7171 for exterior identification if applicable.
   2. Contact each utility owner.
   3. Arrange for the identification of the locations of existing underground facilities at or contiguous to the site.

B. Utility Interruptions:
   1. Provide 7 days notice to the affected occupants of the time and duration of the anticipated shut off.
   2. Notify Fire Department 72 hours in advance if water main or fire supply line shut off is required.

1.4 PROTECTION AND RELOCATION

A. Be responsible for:
   1. Protection of structures and utilities at or contiguous to the site in accordance with the General Conditions.
   2. Cost of cleaning, repair, relocation, raising, lowering, or replacement of structures and utilities which are damaged as a result of the Contractor's operations.
   3. Cost of cleaning, repair, relocation, raising, lowering, or replacement of structures and utilities which are identified on the Drawings for relocation.
   4. Temporary sheeting, bracing, poles, cables, sand fill or other means used to support a structure or utility exposed or endangered by the Contractor's operations.
   5. Relocating, raising or lowering of a structure or utility for the Contractor's convenience.

1.5 RESTORATION

A. Acceptable Standards for Restoration:
   1. Restore to the better of the following:
      a. Original condition.
      b. Requirements of the Contract Documents.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 18 13
SECTION 01 23 00 – ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including Owner's Division 00, General and Supplementary Conditions, and Division 01 Specification Sections, apply to this Section.

B. Division 01 provisions of the Construction Specification, and the Construction Drawings, apply to this Section.

1.2 SUMMARY

A. This Section identifies each alternate and describes the basic changes to be incorporated into the Work, only when that alternate is made a part of the Work by specific provisions of the Contract Documents.

1.3 SCHEDULE OF ALTERNATES

A. Add Alternate 1:
   1. New First Floor Unisex Restroom:
      a. Provide all work and materials to construct a new unisex barrier-free toilet room, including but not limited to all new walls, doors, floors, ceilings, plumbing fixtures, and drinking fountain.
      b. Refer to architectural, electrical, and mechanical drawings.

B. Add Alternate 2:
   1. Conference Room Built-in Casework:
      a. Provide all material and labor to construct the new built-in casework in room 216 on the second floor.
      b. Refer to architectural, electrical, and mechanical drawings.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 23 00
SECTION 01 25 13 – PRODUCT SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including Owner's Division 00, General and Supplementary Conditions, and Division 01 Specification Sections, apply to this Section.

B. Division 01 provisions of the Construction Specification, and the Construction Drawings, apply to this Section.

1.2 SUMMARY

A. This Section includes the administration of substitutions and Product options.

1.3 SUBMITTALS

A. List of all products proposed for installation:
   1. Submit 5 copies within 30 days after the Effective Date of Agreement unless otherwise indicated elsewhere in the Contract Documents.
   2. Tabulate the list by each Specification Section.

1.4 CONTRACTOR'S OPTIONS

A. Products specified only by reference standards or by description:
   1. Select any Product meeting the standards or description by any Supplier unless otherwise required elsewhere in the Contract Documents.
   2. Submit for Architect's review:
      a. Name and address of Supplier.
      b. Trade name.
      c. Model or catalog designation.
      d. Manufacturer's data including:
         1) Performance and test data
         2) Compliance with reference standards.

B. Products specified by naming one or more suppliers without an "or equal" clause:
   1. Use specified Product of one of the Suppliers named.
   2. No substitutions.

C. Products specified by naming one or more suppliers with an "or equal" clause:
   1. Indicates the option of selecting equivalent Products by stating "or equal" after the specified Suppliers.
   2. Architect may waive some or all of the requirements specified for substitutions if, at Architect's sole discretion, the proposed equivalent Product is considered an "or equal".
   3. If, at Architect's sole discretion, the proposed equivalent Product does not qualify as an "or equal", it will be considered as a proposed substitute and a substitution request submittal will be required.

1.5 SUBSTITUTIONS

A. Substitutions after the effective date of agreement:
   1. Within 30 days after the Effective Date of Agreement.
   2. Architect will consider formal requests for substitution of Products in place of those specified unless otherwise prohibited elsewhere in the Contract Documents.

B. Substitution Request Submittals: Submit 5 copies of the request for substitution including the following:
   1. Complete data substantiating compliance of the proposed substitution with the Contract Documents.
   2. For Products:
      a. Names and addresses of Manufacturer and Supplier.
      b. Product identification.
c. Manufacturer's literature, including:
   1) Product description.
   2) Performance and test data
   3) Reference standards.

   d. Samples.

e. Name and address of similar projects on which the Product was used and date of installation.

3. For Construction Methods:
   a. Detailed description of the proposed method.
   b. Drawings illustrating methods.

4. Itemized comparison of proposed substitution with Product or method specified.

5. Data relating to changes in the construction schedule.

6. Accurate cost data on the substitution and comparison with the Product or method specified.

7. Changes to the Work which would be caused by the substitution.

C. Contractor's Responsibilities: In making a request for a substitution, Contractor represents:
   1. Contractor has personally investigated the proposed Product or method and determined that it is equal
      or superior in all respects to that which is specified.
   2. Contractor will provide the same guarantee for the substitution as for the Product or method specified.
   3. Contractor will coordinate installation of the accepted substitution into the Work making such changes
      as may be required for the Work to be completed in all respects.
   4. Contractor waives all claims for additional cost related to the substitution which consequently become
      apparent.
   5. Cost data is complete and includes all related costs under Contractor's contract, but excludes costs
      under separate contracts and Architect’s redesign costs.

D. Substitutions Not Considered: Substitutions will not be considered if:
   1. They are indicated or implied on Shop Drawings or Product data submittals without formal request
      submitted in accordance with this Section.
   2. Acceptance will require substantial revision of the Contract Documents.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 25 13
SECTION 01 26 13 – REQUESTS FOR INFORMATION

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 procedures for Contractor to give notice of conflicts, errors, ambiguities, or discrepancies in the Contract Documents.

1.3 DEFINITIONS

A. Abbreviation: Request for Information (RFI).

1.4 REQUESTS FOR INFORMATION

A. Format:
   1. Use the enclosed RFI form or, at Contractor's option, generate form.
   2. Minimum required content of Contractor's RFI form:
      a. Project name.
      b. Name and address of Contractor.
      c. RFI number.
      d. RFI date.
      e. Name of initiator.
      f. Complete written request, with sketches as required.
      g. Signature of initiator.
      h. Space for written response by Engineer, with signature and date of Engineer's representative.

B. Procedures:
   1. Maintain a log of RFIs, including the RFI date and the date of the response.
   2. Allow at least 10 full working days for Engineer's response following Engineer's receipt of RFI.
   3. Submit written justification for shorter response time.
   4. Do not submit RFIs for information already included in the Contract Documents.
   5. Illegitimate RFIs may be cause for deductions in the Contract amount. See the Supplementary Conditions.
   6. RFIs submitted directly by subcontractors or vendors will be rejected.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 SCHEDULES

A. Attached is the following form suggested for use on this project:
   1. Request for Information.
REQUEST FOR INFORMATION
PAGE 1 OF 1

CONTRACT FOR: PROJECT NO.:

OWNER:

CONTRACTOR:

ENGINEER:

THE CONTRACTOR SHALL COMPLY WITH THE PROCEDURES IN DIVISION 01 SECTION “REQUESTS FOR INFORMATION.”

RFI No.: ____________________________

FTCH Project Manager: ____________________________

REQUEST

RFI From: ____________________________ Signature: ____________________________ Date: ____________________________

RESPONSE

Response From: ____________________________ Signature: ____________________________ Date: ____________________________

END OF SECTION 01 26 13
SECTION 01 31 13 – PROJECT COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including Owner’s Division 00, General and Supplementary Conditions, and Division 01 Specification Sections, apply to this Section.

B. Division 01 provisions of the Construction Specification, and the Construction Drawings, apply to this Section.

1.2 SUMMARY

A. This Section includes provisions for coordination of the Work.

1.3 GENERAL COORDINATION

A. Coordinate scheduling, submittals and work of the various Sections of the Specifications to:
   1. Ensure efficient and orderly sequence of installation of interdependent construction elements.
   2. Provide for items to be installed later.

B. Interrelated Operating Equipment:
   1. Verify that characteristics of elements are compatible.
   2. Coordinate work of various sections having interdependent responsibilities for:
      a. Installation.
      b. Connection.
      c. Placing in service.

C. Shutdown of Existing Systems: Complete the WSU Building Notification Form regarding all impacts to the building and forward for approval 7 calendar days in advance of any shutdown of, or impact to, existing building systems.

D. In finished areas, except as otherwise indicated:
   1. Conceal pipes, ducts and wiring in the construction.
   2. Coordinate locations of fixtures and outlets with finish elements.

1.4 ACCEPTANCE OF CONDITIONS

A. Inspection:
   1. Prior to performing any work under a section:
      a. Carefully inspect the installed work.
      b. Verify that all such work is complete to the point where the work under that Section may properly commence.
      c. Starting of work indicates acceptance of the condition of components to which the work will be applied.
   2. Verify that all materials, equipment and Products to be installed under a Section may be installed in strict accordance with the original design and reviewed Shop Drawings.

B. Discrepancies:
   1. Resolve all discrepancies and conflicts between the trades.
   2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

1.5 SLEEVES AND INSERTS

A. Function: For pipes, conduits and similar items in forms, walls, partitions and floors.

B. Trades: Furnish required sleeves and inserts.
C. Place sleeve and inserts in ample time so as to not delay work.

D. Except as approved by Architect, do not place sleeves vertically through:
   1. Beams.
   2. Girders.
   3. Similar construction.

E. Maintain in proper position during subsequent work.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 31 13
SECTION 01 31 19 – PROJECT MEETINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including Owner’s Division 00, General and Supplementary Conditions, and Division 01 Specification Sections, apply to this Section.

B. Division 01 provisions of the Construction Specification, and the Construction Drawings, apply to this Section.

1.2 SUMMARY

A. This Section includes scheduling and administering of preconstruction and progress meetings.

B. Scheduling and Administration of Meetings:
   1. Responsibility:
      a. Preconstruction Meeting: Owner.
      b. Progress Meetings: Contractor.
   2. Procedures:
      a. Prepare agenda.
      b. Distribute written notice and agendas of meetings 4 days in advance of the meeting date.
      c. Make physical arrangements for the meetings.
      d. Preside at meetings.
      e. Record minutes and include significant proceedings and decisions.
      f. Distribute copies of the minutes within 4 days after meetings to:
         1) Participants.
         2) Others affected by proceedings.

1.3 PRECONSTRUCTION MEETING

A. Schedule: Preconstruction meeting will be scheduled by Owner:
   1. Before starting the Work at the Site.

B. Attendance: Representatives of the following parties are to be in attendance at the meeting:
   1. Owner.
   3. Contractor.

1.4 PROGRESS MEETINGS

A. Types of Progress Meetings:
   1. Regular.
   2. Called.

B. Schedule meetings as follows unless otherwise approved by Architect:
   1. Regular: Weekly.
   2. Called: As the progress of the Work dictates.

C. Location: Hold meetings at Site or as indicated in the notice.

D. Attendance: Representatives of the following parties are to be in attendance at the meeting:
   1. Architect/Engineer.
   2. Contractor.
   3. Owner’s representative as appropriate.
E. Minimum Agenda: The minimum agenda for progress meetings shall consist of the following:
   1. Review and approve minutes of previous meetings.
   2. Review safety procedures and protocols.
   3. Review progress of the Work since the previous meeting.
   4. Note field observations, problems and decisions.
   5. Identify problems which impede planned progress.
   6. Develop corrective measures and procedures to regain approved schedule.
   7. Revise construction schedule as indicated.
   8. Review submittal schedules; expedite as required to maintain schedule.
  10. Review changes proposed by Owner for their effect on the construction schedule and completion date.
  11. Identify all claims and potential claims.
  12. Pending changes and substitutions.
  13. Complete other current business.

PART 2 - PRODUCTS
Not used.

PART 3 - EXECUTION
Not used.

END OF SECTION 01 31 19
SECTION 01 32 16 – CONSTRUCTION PROGRESS SCHEDULE

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 preparation, furnishing, distribution and periodic revision of construction progress schedules.

PART 2 - PRODUCTS

2.1 FORM OF SCHEDULE

A. Preparation:
   1. Prepare in the form of a horizontal bar chart, CPM network, or other form as approved by the Architect prior to submission.
   2. Provide a separate horizontal bar column or path for each trade or operation.
   3. Prepare the schedule in the chronological order of the beginning of each item of work.
   4. Identify each column or path by:
      a. Major Specification Section number.
      b. Distinct graphic delineation.
   5. Use a horizontal time scale and identify the first work day of each week.
   6. Allow space for updating.

B. Size: The schedule sheets shall be 11 inches x 17 inches unless otherwise approved by the Architect.

2.2 CONTENT OF SCHEDULES

A. Construction Sequence:
   1. Provide a complete sequence of construction by activity Milestones.
   2. For Shop Drawings, project data and Samples indicate the following:
      a. Submittal dates.
      b. Dates review copies will be required.
   3. Show decision dates for selection of finishes.
   4. Show Product procurement and delivery dates.
   5. Show dates for beginning and completion of each element of construction.

B. Percentage Completion: Show the projected percentage of completion for each item of work as of the first day of each month.

C. Subschedules:
   1. Provide separate subschedules showing submittals, review times, procurement schedules and delivery days.
   2. Provide subschedules to define critical portions of the entire schedule.
PART 3 - EXECUTION

3.1 SUBMITTAL

A. Preliminary Schedule:
   1. Submit the preliminary schedule within 10 days after the date of the Owner’s signature on the Agreement Supplement.
   2. The Architect will review schedule and will return the reviewed copy within 15 days after receipt.
   3. If required, resubmit within 7 days after receipt of a returned review copy.
   4. Upon request, meet with the Architect at least 10 days prior to the submission of the first Application for Payment to review the schedule.

B. Periodic Adjustment: Monthly, submit a revised schedule accurately depicting adjustments and progress to the first day of each month.

C. Number of Copies: Submit the number of copies required by the Contractor, plus 4 copies to be retained by the Architect.

3.2 DISTRIBUTION

A. Reviewed Schedules: Distribute copies of the reviewed schedules to:
   2. Subcontractors.
   3. Other concerned parties.

B. Instructions to Recipients: Instruct recipients to report inability to comply with the schedule, and provide detailed explanations with suggested remedies.

3.3 ADJUSTMENT OF PROGRESS SCHEDULE

A. Changes: Show changes occurring since previous submission of the schedule.

B. Progress: Indicate progress of each activity and show completion dates.

C. Other Items:
   1. Include major changes in scope.
   2. Include activities modified since previous updating.
   3. Include revised projections due to changes.
   4. Include other identifiable changes.

D. Narrative Report:
   1. Provide a narrative report including:
      a. A discussion of problem areas including current and anticipated delay factors and their impact.
      b. Direct action taken, or proposed, and its effect.
      c. A description of revisions including:
         1) Their effect on the schedule due to change of scope.
         2) Revisions in duration of activities.
         3) Other changes that may affect the schedule.
      d. The status of completion of Milestones.

END OF SECTION 01 32 16
SECTION 01 33 00 – SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including Owner’s Division 00, General and Supplementary Conditions, and Division 01 Specification Sections, apply to this Section.

B. Division 01 provisions of the Construction Specification, and the Construction Drawings, apply to this Section.

1.2 SUMMARY

A. This Section includes procedures for the submittal of Shop Drawings, Product Data, Samples, Operation and Maintenance Manuals, and other information.

B. Related Sections include pertinent Sections of these Specifications for the individual Submittals required.

C. Submittal of samples to be in duplicate with Owner and A/E each receiving full submittal.

1.3 DEFINITIONS

A. Submittal: Information sent by Contractor to convey information about systems, equipment, materials, products, and administrative matters for the Work.

B. Resubmittal: Submittal sent for review a second or further time.

C. Product Data: Illustrations, standard schedules, diagrams, performance charts, instructions, brochures, or manufacturer’s literature that describe the physical size, appearance, and other characteristics of materials or equipment for a portion of the Work.

D. Shop Drawings: Drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

E. Samples: Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

F. Action Submittals: Submittals that require A/E’s response.

G. Informational Submittals: Submittals that do not require A/E’s response.

H. Delegated-Design: In certain individual Specification Sections, design services or certifications by a design professional that are specifically delegated to the Contractor. Performance and design criteria are defined in the individual Specification Sections or on the Drawings. Contractor is solely responsible for design of those items or systems, and achieving specified performance.

1.4 SUBMITTAL PROCEDURES

A. Submittal Schedule:
1. Prepare and submit a Submittal schedule that identifies the following for each Submittal:
   a. Submittal number
   b. Submittal description
   c. Projected date Submittal will be submitted; based on when material is required on the job and in support of the project completion date.
2. An electronic copy (MS Excel file) of a blank Submittal schedule, in the preferred format, will be furnished by Architect at the preconstruction meeting.
3. Submittal Numbers:
   a. Use the applicable Specification Section number followed by a decimal point and then a sequential number (e.g., 06 10 00.1). Where a Submittal is required via a Drawing (instead of a Specification Section), use the applicable Drawing Number followed by a decimal point and then a sequential number (e.g., M501.1.1).
   b. Resubmittals shall include a letter suffix after another decimal point (e.g., 06 10 00.1.A).
   c. Submittals that are not numbered correctly may be rejected.

B. Delivery Method:
1. Submittals may be delivered as paper copies or electronic files at Contractor’s option.
2. Advise A/E of delivery method to be used at the preconstruction meeting.
3. Where Submittals include information that is intended to be printed on sheets larger than 11 inches x 17 inches, or where scale or drawing size are critical for proper review, submit 3 paper copies for review.
4. Paper Copies:
   a. Unless indicated otherwise, submit 3 copies of each Submittal.
   b. One copy of each Action Submittal will be returned to Contractor.
   c. Extra copies submitted by Contractor will be discarded.
5. Electronic Files:
   a. Unless indicated otherwise, submit 1 copy of each Submittal in PDF format.
   b. Scanned Submittals shall be produced in such a way as to not compromise the graphic quality or accuracy of scale, where applicable; and text shall be searchable.
   c. One copy of each Action Submittal will be returned to Contractor.
   d. Submittals may be transmitted via electronic mail (e-mail) or on a CD or DVD. Submittals that are transmitted electronically may be returned electronically at the Architect’s discretion.
6. Transmit Submittals to party and address identified by Architect at preconstruction meeting.

C. Coordination and Timing: Coordinate preparation and processing of Submittals with performance of construction activities. Contractor is responsible for cost of delays caused by lack of coordination or tardiness of Submittals. Incomplete Submittals will be rejected.
1. Coordinate each Submittal with fabrication, purchasing, testing, delivery, other Submittals, and related activities that require sequential activity.
2. Coordinate transmittal of different types of Submittals for related parts of the Work so processing will not be delayed because of need to review Submittals concurrently for coordination.
   a. Architect reserves the right to withhold action on a Submittal requiring coordination with other Submittals until related Submittals are received.

D. Processing Time: Allow 10 full working days for Architect to review each Submittal, including Resubmittals. Time for review shall commence on Architect’s receipt of Submittal. No extension of the Contract Time will be authorized because of failure to transmit Submittals enough in advance of the Work to permit processing, including Resubmittals. Architect will advise Contractor when a Submittal being processed must be delayed for coordination.

E. Identification: Place a permanent label on each Submittal or generate a separate cover sheet.
1. Indicate name of firm or entity that prepared Submittal.
2. Provide space to record Contractor’s review and approval markings and action taken by Architect.
3. Include the following information:
   a. Project name.
   b. Date.
   c. Name and address of Architect.
Submittal Procedures

Wayne State University
University Services Building – HVAC and Fire Alarm
WSU Project Number 060-313984
FTCH Project Number 180756

Section 01 33 00

Submittal Procedures

1.5 CONTRACTOR’S USE OF ARCHITECT’S ELECTRONIC DRAWING FILES

A. At Contractor’s written request, copies of Architect’s electronic Drawing files of the floor plans may be provided to Contractor for Contractor’s use in connection with Project, including Submittal preparation. Electronic files may be furnished by Architect for the convenience of the Contractor. Conclusions or information obtained or derived from such electronic files will be at the Contractor’s sole risk. Materials furnished by Architect that may be relied upon are limited to printed Contract Documents.

B. When Contractor uses Architect’s electronic Drawing files to facilitate Submittal preparation, prepare Submittals to be project specific. Submittals that are not project specific, including Architect’s Drawing files submitted on a new title block, will be rejected.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

A. General: Prepare and submit project specific Action Submittals required by individual Specification Sections. Do not use highlighting that would not be reproducible.

B. Product Data: Collect information into a single Submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for Submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.

2. Mark each copy of each Submittal to indicate which products and options are applicable.

3. Include the following information, as applicable:

   a. Manufacturer's written recommendations.
   b. Manufacturer's product specifications.
   c. Manufacturer's installation instructions.
Section 01 33 00

Submittal Procedures

Wayne State University
University Services Building – HVAC and Fire Alarm
WSU Project Number 060-313984
FTCH Project Number 180756

1. Color charts as required by individual Specification Sections.
2. Manufacturer's catalog cuts.
3. Wiring diagrams showing factory-installed wiring.
4. Printed performance curves.
5. Operational range diagrams.
6. Mill reports.
7. Standard product operation and maintenance manuals.
8. Compliance with specified referenced standards.
9. Testing by recognized testing agency.
10. Application of testing agency labels and seals.
11. Notation of coordination requirements.

4. Submit Product Data before or concurrent with Samples.

5. Maintain copy of returned Submittal for Project records.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale where appropriate. Scale shall be sufficiently large to indicate pertinent features of the item and its method of connection to the Work.

1. Preparation: Fully illustrate requirements of the Contract Documents. Include the following information, as applicable:
   a. Dimensions.
   b. Identification of products.
   c. Fabrication and installation drawings.
   d. Colors and materials as applicable.
   e. Roughing-in and setting diagrams.
   f. Wiring diagrams showing field-installed wiring, including power, signal, control, and communication wiring. Differentiate between Manufacturer-installed and field-installed wiring.
   g. Manufacturing instructions.
   h. Templates and patterns.
   i. Schedules.
   j. Calculations.
   k. Compliance with specified standards.
   l. Notation of coordination requirements.
   m. Notation of dimensions established by field measurement.
   n. Relationship to adjoining construction clearly indicated.

2. Sheet Size: Submit Shop Drawings on sheets at least 8-1/2 inches x 11 inches but no larger than 36 inches x 48 inches.

3. Maintain copy of returned Submittal for Project records.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements, and for a comparison of these characteristics between Submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components, such as accessories, together in one Submittal package.

2. Identification: On unexposed side of Samples, attach label that includes the following:
   a. Generic description of Sample.
   b. Product name and name of Manufacturer.
   c. Sample source.
   d. Number and title of appropriate Specification Section.

3. Samples for Initial Selection: Submit Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available. Where Contract Documents indicate custom color or material, coordinate production of custom Samples with the Architect and Manufacturer prior to submittal.
   a. Number of Samples: Unless indicated otherwise, submit 3 full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from Manufacturer's product line. A/E will return 1 Sample with options selected.

4. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, physically identical with material or product proposed for use, and that show full range of color and texture variations expected.

5. Samples include, but are not limited to, the following: Partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
6. **Number of Samples**: Unless indicated otherwise, submit 3 sets of Samples to A/E and 1 set to Owner. A/E will retain 1 Sample set; remainder will be returned. Owner will retain samples.
   a. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
   b. If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

7. **Disposition**: Maintain sets of approved Samples at Site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used by A/E to determine final acceptance of construction associated with each set.
   a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples shall be in an undamaged condition at time of Substantial Completion.
   b. Samples not incorporated into the Work, or otherwise designated to become Owner's property, are the property of Contractor.

E. **Operation and Maintenance Manuals**:
   1. **General**:
      a. Where manuals are required to be submitted covering items included in the Work, prepare such manuals in durable plastic binders approximately 8-1/2 inches X 11 inches in size and with at least the following:
         1) Identification on, or readable through, the front cover stating general nature of the manual.
         2) Neatly typewritten index near the front of the manual.
         3) Complete instructions regarding operation and maintenance of equipment involved, including:
            a) Equipment function, normal operating characteristics, and limiting conditions.
            b) Assembly, installation, alignment, adjustment, and checking instructions.
            c) Operating instructions for start-up, routine and normal operating, regulation and control, shutdown, and emergency conditions.
            d) Maintenance instructions, including lubrication requirements where applicable.
            e) Guide to "troubleshooting".
            f) Parts lists and predicted life of parts subject to wear.
            g) Project specific outline and cross sections, assembly drawings, Architecting data, and wiring diagrams. Wiring diagrams shall reflect final, as-installed conditions and include wire numbers.
            h) Test data and performance curves.
         4) Complete nomenclature of all replaceable parts, their part numbers, current costs, and name and address of nearest vendor of parts.
         5) Copies of guarantees and warranties issued.
         6) Copies of the reviewed Submittals.
         7) Copies of data concerning changes made during construction.
   2. **Extraneous Data**: Where contents of the manuals include Manufacturer's catalog pages, clearly indicate the precise items included in this installation and delete all Manufacturers' data with which this installation is not concerned. Do not use highlighting that would not be reproducible.
   3. **Number of Copies Required**: Unless otherwise specifically directed by A/E, or stipulated in the pertinent Section of these Specifications:
      a. For review, submit 1 paper and 1 electronic copy.
      b. For record, deliver 4 paper and 1 electronic copies to A/E and Owner.
   4. Schedule delivery of record copies of operation and maintenance manuals at least 60 days prior to startup of respective equipment, unless otherwise specified.

2.2 **INFORMATIONAL SUBMITTALS**

A. **General**: Prepare and submit Informational Submittals required by individual Specification Sections. Do not use highlighting that would not be reproducible.

B. **Certificates and Certifications**: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
C. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects/Architects and owners, and other information specified.

D. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

E. Installer Certificates: Prepare written statements on Manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by Manufacturer for this Project.
   1. Special attention to Low Voltage Electrical System installer.

F. Manufacturer Certificates: Prepare written statements on Manufacturer's letterhead certifying that Manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

G. Product Certificates: Prepare written statements on Manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

H. Material Certificates: Prepare written statements on Manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

I. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

J. Product Test Reports: Prepare written reports indicating current product produced by Manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by Manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

K. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
   1. Name of evaluation organization.
   2. Date of evaluation.
   3. Time period when report is in effect.
   4. Product and manufacturers' names.
   5. Description of product.
   6. Test procedures and results.
   7. Limitations of use.

L. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

M. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

N. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents; such as, but not limited to WSU C&IT test report requirements.
O. Manufacturer's Instructions: Prepare written or published information that documents Manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of Manufacturer. Include the following, as applicable:
1. Preparation of substrates.
2. Required substrate tolerances.
3. Sequence of installation or erection.
4. Required installation tolerances.
5. Required adjustments.
6. Recommendations for cleaning and protection.

P. Manufacturer's Field Reports: Prepare written information documenting tests and inspections of factory-authorized service representative. Include the following, as applicable:
1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement of substrate condition and acceptability of substrate for installation or application of product.
3. Statement that products at Site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
8. Other required items indicated in individual Specification Sections.

Q. Material Safety Data Sheets (MSDSs): Submit information directly to Owner; do not submit to A/E.
1. A/E will not review Submittals that include MSDSs and will return the entire Submittal for Resubmittal.

2.3 DELEGATED-DESIGN SUBMITTALS

A. Where design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

B. Performance type design documents and calculations shall be prepared by a design professional as required by the individual Specification Section, licensed in the State where the Project is being constructed. Design documents shall be signed and sealed by the responsible design professional. Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Identify name and version of software, if any, used for calculations.

C. In addition to Shop Drawings, Product Data, and other required Submittals, submit two copies of a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Review each Submittal and check for coordination with other work of the Contract and for compliance with the Contract Documents. Verify field dimensions and conditions; note corrections as necessary. Mark with approval stamp before submitting to A/E.
1. Approval Stamp: Stamp each Submittal with an approval stamp. Use the same stamp format for each Submittal. Include Project name and location, Submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that Submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
B. Submittals that are not approved and stamped by Contractor will be rejected.

3.2 POSTING

A. Contractor to post reviewed submittals and shop drawings to a FTP site; and provide access to Owner, Architect, and all other project team members.

3.3 A/E’S REVIEW

A. Action Submittals: A/E will review Action Submittals, make marks to indicate corrections or modifications required, and return Submittal. A/E will stamp each Submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
1. Reviewed, No Exceptions Noted: Submittal appears to conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
2. Reviewed With Corrections Noted: Upon incorporation of review comments, it appears that Submittal will conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
3. Revise and Resubmit: Submittal has one or more specific segments that are incomplete, do not appear to conform to the information given in the Contract Documents, or are incompatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Contractor shall resubmit information for review to demonstrate understanding of comments and portions of Work to be provided. Except as noted, Contractor shall not proceed with work related to Submittal.
4. Rejected, Resubmit: Submittal as a whole is incomplete, does not appear to conform to the information given in the Contract Documents, or is incompatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Contractor shall resubmit information for review to demonstrate understanding of comments and portions of Work to be provided. Contractor shall not proceed with work related to Submittal.

B. Informational Submittals: Other Submittals required by the Contract Documents are for information only. A/E will acknowledge receipt of Informational Submittals. Such Submittals include, but are not limited to:
1. Qualifications Data.
2. Certificates.
3. Test Reports.
4. Manufacturer’s Instructions.
5. Maintenance Data.
6. Field Reports.


D. Submittals not required by the Contract Documents will be returned without being reviewed.

E. Partial Submittals are not acceptable, will be considered non-responsive, and will be rejected.

3.4 RE-REVIEW COSTS

A. Compensation:
1. Should A/E be required to review a Submittal more than twice because of failure of the Submittal to meet the requirements of the Contract Documents, A/E will record A/E’s expenses for performing additional reviews.
2. Owner will compensate A/E for these additional services and deduct the amount paid from payments to Contractor.

END OF SECTION 01 33 00
SECTION 01 42 00 – REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including Owner’s Division 00, General and Supplementary Conditions, and Division 01 Specification Sections, apply to this Section.

B. Division 01 provisions of the Construction Specification, and the Construction Drawings, apply to this Section.

C. WSU Construction Design Standards, C&IT Communication Standards, Wayne State University Police Standards, and all other WSU testing requirements, permitting, and other regulatory considerations.

1.2 SUMMARY

A. This Section includes provisions for references throughout the Contract Documents.

1.3 DEFINITIONS

A. Abbreviations:

1. AASHTO - American Association of State Highway and Transportation Officials, 444 North Capitol Street, N.W., Suite 249, Washington, DC 20001.
2. ACI - American Concrete Institute, 38800 Country Club Dr., Farmington Hills, MI 48331.
3. AISC - American Institute of Steel Construction, Inc., One East Wacker Dr., Suite 700, Chicago, IL 60601-1802.
5. ANSI - American National Standards Institute, 25 West 43rd St., 4th Floor, New York, NY 10036.
7. ASTM - American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959.
8. AWS - American Welding Society, Inc., 550 N.W. LeJeune Road, Miami, FL 33126.
9. AWWA - American Water Works Association, 6666 West Quincy Avenue, Denver, CO 80235.
10. CPA – Composite Panel Association, 19465 Deerfield Avenue, Suite 306, Leesburg, VA 20176.
11. CRSI - Concrete Reinforcing Steel Institute, 933 Plum Grove Road, Schaumburg, IL 60173-4758.
12. MDEQ – Michigan Department of Environmental Quality, 525 West Allegan Street, P.O. Box 30473, Lansing, MI 48909-7973.
13. MDNR - Michigan Department of Natural Resources, 530 West Allegan Street, P.O. Box 30028, Lansing, MI 48909.
14. MDOT - Michigan Department of Transportation, 425 West Ottawa Street, P.O. Box 30050, Lansing, MI 48909.
15. MDCH - Michigan Department of Community Health, 201 Townsend Street, Lansing, MI 48913.
16. MIOSHA - Michigan Department of Licensing and Regulatory Affairs, Michigan Occupational and Health Administration, State Secondary Complex, 7150 Harris Drive, P.O. Box 30643, Lansing, MI 48909-8143.
17. NCMA - National Concrete Masonry Association, 13750 Sunrise Valley Drive, Herndon, VA 20171-4662.
18. NEC - National Electrical Code (see NFPA 70).
19. NEMA - National Electrical Manufacturers’ Association, 1300 N. 17th Street N.W., Suite 1752, Rosslyn, VA 22209.
21. PCI - Precast Concrete Institute, 200 West Adams, Suite 2100, Chicago, IL 60606.
22. SDI - Steel Deck Institute, P.O. Box 25, Fox River Grove, IL 60021.
23. SJI - Steel Joist Institute, 234 West Cheves Street, Florence, SC 29501.
24. UL - Underwriters’ Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.
1.4 REFERENCES

A. The provisions of the Contract Documents shall govern over any conflicting provisions of the referenced documents.

B. The provisions of laws and regulations shall govern over any conflicting provisions of the referenced documents.

C. Comply with the referenced document that is in effect as of the Bid date, except when a specific date is specified.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 42 00
SECTION 01 50 00 – TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including Owner's Division 00, General and Supplementary Conditions, and Division 01 Specification Sections, apply to this Section.

B. Division 01 provisions of the Construction Specification, and the Construction Drawings, apply to this Section.

1.2 SUMMARY

A. This Section includes the following items to facilitate construction:
   2. Contractor's field offices.
   4. Temporary heat.
   5. Temporary partitions.
   6. Storage areas.
   7. Project signs.

1.3 SUBMITTALS

A. Samples: For construction project identification sign.
   1. Required Sample:
      a. 11 x 17 color proofs of sign representing actual appearance of sign producer's final product.
      b. Created by sign producer.
   2. Submit and obtain review by Architect prior to printing final version of vinyl.

1.4 STORAGE AREAS

A. Locations:
   1. Interior: There will be no predesignated interior storage area(s) for contractor use.
      a. Storage needs beyond what can be accommodated within the limits of the area under construction will be considered by the Owner on an individual basis.

PART 2 - PRODUCTS

2.1 UTILITIES

A. Temporary Utilities:
   1. Water: Obtain water by connection to Owner's existing water system.
   2. Electricity:
      a. Obtain electrical power by connecting to Owner's existing system.
      b. Furnish, install, remove and pay for all temporary wiring, equipment switches, panels, connections and transformers.
      c. Furnish, install, remove, and pay for area distribution boxes so located that power and artificial lighting are located at all points where required by the Work.
      a. Provide lighting levels meeting minimum requirements for proper performance and observation of the work.
      b. Existing lighting fixtures to be demolished may remain in place if not prohibiting execution of work.
   5. Sanitary Facilities: Specific restrooms within the building will be designated for contractor use.
      a. Condition of facilities to be maintained in clean and orderly fashion.
2.2 FIELD OFFICES

A. Contractor's Field Office:
   1. No trailer will be allowed on University property.
   2. Contractor's office functions to be handled within limits of construction.

2.3 CONSTRUCTION HEATING

A. Permanent Heating Equipment:
   1. Prior to use in areas of construction, provide adequate means to keep internal duct and acoustic liner surfaces clean and in a like-new condition.
   2. Filters:
      a. Securely supported at each return and exhaust air open duct end and grille.
      b. Support filter length at required intervals to prevent filter deformation.
      c. Replaced at intervals required to keep internal duct and acoustic liner surfaces free of construction debris and dust.
   3. At substantial completion of space(s) being served in the work area, ductwork used by Contractor shall be cleaned to Engineer's satisfaction.

B. Temperatures:
   1. Except as otherwise called for, a minimum temperature of 50 degrees F and a maximum temperature of 75 degrees F in construction areas shall be maintained at all times.
      a. Maintain typical temperatures in areas of general building use.
   2. See requirements of various other Sections of these Specifications for minimum temperature to be maintained for the application of work under the various trades.

2.4 TEMPORARY PARTITIONS

A. Provide separation between public areas and work area, where existing door or wall is temporarily removed.
   1. Wall must have smoke/fire rating as required by Code and AHJ.
   2. Wall must not damage existing surfaces to remain.
   3. See Drawings for specific requirements.

2.5 STORAGE AREAS

A. Construction materials and supplies to be kept within the confines of the work areas.

2.6 PROJECT IDENTIFICATION SIGNAGE

A. No signage announcing names of parties involved with construction process will be allowed on University property.

PART 3 - EXECUTION

3.1 REMOVAL

A. Maintain all temporary facilities and controls as long as needed for the safe and proper completion of the Work. Remove all such temporary facilities and controls as rapidly as progress of the Work will permit. Remove exterior sign when directed to by Owner.

END OF SECTION 01 50 00
SECTION 01 66 00 – PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including Owner’s Division 00, General and Supplementary Conditions, and Division 01 Specification Sections, apply to this Section.

B. Division 01 provisions of the Construction Specification, and the Construction Drawings, apply to this Section.

1.2 SUMMARY

A. This Section includes provisions for the storage and protection of Products.

1.3 STORAGE AND PROTECTION

A. Delivery: All contractor deliveries to be supervised, received at the loading dock, and routed coordinated in advance with the Dock manager. Large material deliveries and large items are not allowed through the main entrance.

B. Storage:
   1. Maintain ample way for foot traffic at all times, except as otherwise approved by A/E or Owner.
   2. Repair or replace property damaged by reason of storing of material at no additional cost to Owner.
   3. Packaged Materials:
      a. Delivered in original, unopened containers.
      b. Stored until ready for use.
   4. Materials shall meet the requirements of these Specifications at the time that they are used in the Work.
   5. Store Products in accordance with Manufacturer’s instructions.

C. Protection:
   1. Use all means necessary to protect the:
      a. Products of every Section before, during and after installation.
      b. Installed work and materials of all trades.
   2. All materials shall be delivered, stored and handled to prevent:
      a. The inclusion of foreign materials.
      b. Damage by water, breakage or other causes.

D. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of Architect/Engineer and at no additional cost to Owner.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 66 00
SECTION 01 71 36 – MONITORING OF EXISTING CONDITIONS

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 monitoring of building cracks.

1.3 SYSTEM DESCRIPTION

A. Crack Monitoring: Instrumentation permitting the widths of existing cracks to be measured and reported.

1.4 PERFORMANCE REQUIREMENTS

A. Contractor’s Responsibilities:
   1. Contractor will be held responsible for damage to structures or buildings due to contractual activities.
   2. Repair or replace damaged structures or buildings in a timely fashion and to the satisfaction of the property owner and Owner and at no cost to property owner or Owner.

B. Contractor’s Responsibilities:
   1. Contractor will be held responsible for damage to structures or buildings due to contractual activities.
   2. Repair or replace damaged structures or buildings in a timely fashion and to the satisfaction of the property owner and Owner and at no cost to property owner or Owner.

C. Measuring and Reporting: By Contractor.

1.5 SEQUENCING AND SCHEDULING

A. Install monitoring systems and take initial readings prior to commencement of construction activities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials and workmanship shall conform to the requirements of other Sections of the Specifications.
   1. Where no materials are specified in these specifications, use materials of an equivalent type, quality, and size to match those existing in other areas of the facility.
   2. If none exist, use materials and workmanship recognized as of the highest quality in the industry.
   3. Obtain Architect’s review of all such material and workmanship.

B. Settlement Markers: Stainless steel nails or stainless steel screw anchors.

C. Crack Monitors:
   1. Avongard Calibrated Crack Monitors; or approved equal.
   2. Capable of measuring crack displacement and rotation to 1 mm.
   3. May include use of steel pins or other appropriate devices driven or grouted into concrete.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Preconstruction Survey:
   1. Conducted by Contractor and witnessed by Architect following award of Contract and before beginning construction.
   2. At Contractor’s expense and documented by Contractor in the form of:
      a. Pictures.
      b. Field notes.
   3. Include an assessment of existing structural conditions and documentation of cracks as identified by Architect and Contractor.

3.2 INSTALLATION AND MONITORING

A. Crack Monitoring:
   1. For bidding purposes, make provisions for 5 crack monitors at locations to be identified by Architect following the preconstruction survey to be conducted by Contractor.
   2. Monitor crack monitors as follows:
      a. Daily for 1 week prior to beginning activities that may affect cracks.
      b. Daily during activities that may affect cracks.
      c. Daily for 1 week after completion of activities that may affect cracks.
   3. At end of construction, remove monitors and repair surfaces to match existing.

3.3 CLEANING

A. Clean materials installed under this Section in accordance with Division 01 Section "Cleaning and Waste Management."

END OF SECTION 01 71 36
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 provisions for cutting and patching work.

B. Requirements:
   1. Cutting and patching may be described in various Sections of these Specifications
   2. Execute cutting or patching of work required to:
      a. Make several parts fit properly.
      b. Uncover work to provide for installation of ill-timed work.
      c. Remove and replace defective work.
      d. Remove and replace work not conforming to the requirements of the Contract Documents.
      e. Remove Samples of the installed work as specified for testing.
      f. Install specified work in existing construction.

C. Requirements Upon Architect/Engineer's Instructions:
   1. In addition to Contract requirements, upon written instruction of Architect/Engineer:
      a. Uncover work to provide for Architect/Engineer's observation of covered work.
      b. Remove Samples of installed materials for testing.
      c. Remove work to provide for alteration of existing work.

D. Protection of Work:
   1. Do not endanger any work by cutting or altering the work or any part of it.
   2. Do not cut or alter the work of another trade without written consent of Architect/Engineer.

1.3 SUBMITTALS

A. Written Notice:
   1. Prior to cutting which may affect the structural integrity of the Project or the work of another trade, submit written notice to Architect/Engineer and Owner requesting consent to proceed with cutting.
   2. Required Information:
      a. Identification of Project.
      b. Description of all related defective work.
      c. Necessity for cutting.
      d. Affect on other work or on the structural integrity of the Project.
      e. Description of the proposed work including:
         1) Scope of cutting and patching.
         2) Subcontractor and trades to execute work.
         3) Products proposed to be used.
         4) Extent of refinishing.
      f. Alternatives to cutting and patching.
      g. Designation of party responsible for the cost of cutting and patching.

B. Changes of Materials or Methods:
   1. Should conditions of the Work, or the schedule, indicate change of materials or methods, submit a written recommendation to Architect/Engineer including:
      a. Conditions indicating the change.
      b. Recommendations for alternative materials or methods.
      c. Submittals as required for substitutions.
C. Uncovered Work: Submit written notice to Architect/Engineer's designating the time work will be uncovered to provide for observation.

1.4 DIVISION OF WORK

A. Work:
1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.
2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the Work:
   a. Each trade shall be financially responsible for all cutting and patching for sleeves, penetrations and installation of isolated components as necessary for its work unless herein specifically stated to the contrary.
   b. On renovation projects, Contractor shall cut and patch walls, floors, ceilings to allow for continuous runs of recessed utilities and ductwork.
   c. All patching shall be done by the trade whose work is damaged.
   d. Any cost caused by defective or ill-timed work shall be borne by the party responsible.
   e. Each trade shall do all fitting of its own work as required to make its several components fit together or to receive the work of other contractors.
   f. Holes cut in exterior walls or roofs for installation of mechanical or electrical equipment shall be waterproofed. If existing roofing is to remain, obtain and submit to Owner original roofing manufacturer's approval and warranty on new roof penetrations and where removing existing roof penetrations and curbs.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials and workmanship shall conform to the requirements of other Sections of the Specifications. Where no materials are specified in these specifications, use materials of an equivalent type, quality, and size to match those existing in other areas of the facility. If none exist, use materials and workmanship recognized as of the highest quality in the industry. Obtain Architect/Engineer's review of all such material and workmanship.

PART 3 - EXECUTION

3.1 INSPECTION

A. Existing Conditions: Inspect existing conditions of the Work, including elements subject to movement or damage during cutting and patching or excavating and backfilling.

B. Uncovered Work: After uncovering work, inspect conditions affecting the installation of new Products.

3.2 PREPARATION

A. Shoring and Bracing: Provide shoring, bracing and support as required to maintain structural integrity of the Project.

B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

3.3 PERFORMANCE

A. Adjustments to Products: Execute fitting and adjustments of Products to provide finished installation.
B. Refinishing:
   1. Prepare existing surfaces for finishes by scraping, sanding, filling, acid etching, and sand blasting to ensure bonding and a smooth finish.
   2. Refinish entire surfaces as necessary to provide an even finish.
   3. Refinish continuous surfaces to the nearest intersection.
   4. Refinish entire assemblies.

C. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

D. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
   1. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
      a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

3.4 CLEANING

A. Clean materials installed under this Section in accordance with Division 01 Section "Cleaning and Waste Management."

END OF SECTION 01 73 29
SECTION 01 74 00 – CLEANING AND WASTE MANAGEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes provisions for maintaining structures in a standard of cleanliness.

B. Related Sections: In addition to standards described in this Section, comply with requirements for cleaning as described in various other Sections of these Specifications.

1.3 QUALITY ASSURANCE

A. Inspection:
   1. Daily and more often if necessary.
   2. Conduct inspections to verify that requirements of cleanliness are being met.

1.4 DELIVERY, STORAGE AND HANDLING

A. Hazards Control:
   1. Volatile Wastes:
      a. Store in covered metal containers.
      b. Remove from premises daily.
      c. Provide secondary containment for storage of hazardous materials, as required by Owner, governing authorities and agencies.
   2. Prevent accumulation of wastes which create hazardous conditions.
   3. Provide adequate ventilation during use of volatile or noxious substances.

1.5 PROJECT CONDITIONS

A. Cleaning and Disposal:
   1. Conduct operations to comply with local ordinances and anti-pollution laws.
   2. Not Allowed:
      a. Burning or burying of rubbish or waste materials on Site.
      b. Disposal of volatile wastes in storm or sanitary sewers: Volatile wastes include, but are not limited to, mineral spirits, oil and paint thinner.
      c. Disposal of wastes into streams or waterways.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Compatibility:
   1. Compatible with the surface being cleaned.
   2. Recommended by the Manufacturer of the material being cleaned.
   3. As reviewed by Architect/Engineer.
PART 3 - EXECUTION

3.1 PROGRESS CLEANING

A. General:
1. Store Materials:
   a. In an orderly arrangement allowing maximum access.
   b. Provide for the required protection of materials.
2. Do not allow accumulation of scrap, debris, waste material and other items not required for construction of the Work.
   a. Provide adequate storage for materials awaiting removal.
3. Observe requirements for fire protection and protection of the environment.

B. Buildings and Other Structures:
1. Weekly, and more often if necessary:
   a. Inspect.
   b. Pick up scrap, debris and waste material; remove such items to the place designated for their storage.
   c. Sweep interior spaces clean. Clean shall be defined to be free from dust and other material capable of being removed by reasonable diligence using a hand-held broom.
2. Preparation for installation of succeeding material:
   a. Clean the building or other structure or pertinent portion thereof:
      1) To the degree of cleanliness recommended by the Manufacturer of the succeeding material.
      2) Using equipment and materials required to achieve the required cleanliness.
3. After installation of finish floor material:
   a. Clean the finish floor daily at all times while work is being performed in the space in which finish materials have been installed.
      1) Clean as used above shall be defined to be free from all foreign material which, in the opinion of Architect/Engineer, may be injurious to the finish floor material.
4. Schedule cleaning operations so that dust and other contaminants resulting from cleaning operations will not fall on wet, recently painted surfaces.

3.2 FINAL CLEANING

A. Definitions for Clean: The level of cleanliness generally provided by commercial building maintenance subcontractors using commercial quality building maintenance equipment and materials.

B. Prior to Completion of the Work:
1. Remove from the Site all tools, surplus materials, equipment, scrap, debris and waste.
2. Conduct final progress cleaning as described in Article 3.1 above.

C. Project Areas, Adjacent Spaces, and General Building Areas:
1. Interior:
   a. Visually inspect interior surfaces.
   b. Remove traces of soil, waste material, smudges and other foreign matter.
   c. Remove traces of splashed materials from adjacent surfaces.
   d. Remove paint droppings, spots, stains and dirt from finished surfaces using only the specified cleaning materials and equipment.
2. Glass: Clean glass inside and outside.
3. Polished Surfaces: To surfaces requiring the routine application of buffed polish, apply the specified polish as recommended by the Manufacturer of the material being polished.

D. Timing: Schedule final cleaning as approved by Owner to enable Owner to accept a completely clean Project.
3.3 OWNER OCCUPANCY PRIOR TO SUBSTANTIAL COMPLETION AND ACCEPTANCE

A. If Owner occupies the Work, or a portion of the Work, prior to Substantial Completion and acceptance, then the responsibilities for interim and final cleaning shall be determined by Architect in accordance with the Contract Documents.

END OF SECTION 01 74 00
SECTIoN 01 75 00 – STARTING AND ADJUSTING

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 provisions for the facility start-up and demonstration of the systems as follows:
   1. Equipment.
   2. Mechanical systems.

1.3 SUBMITTALS

A. Preliminary Schedules:
   1. Submit 2 weeks prior to earliest proposed date.
   2. List time and date for the following for each system:
      a. Start-up.
      b. Demonstration to Owner’s representative.

B. Completion Reports:
   1. Submit within 1 week after each system demonstration.
   2. List time, date and persons present for the following for each system:
      a. Start-up.
      b. Demonstration to Owner’s representative.
   3. Include Manufacturer’s representative’s report indicating:
      a. Approval of installation.
      b. Satisfactory start-up.
      c. Functioning correctly.
   4. Indicate that demonstration and instructions were satisfactorily completed.

1.4 QUALITY CONTROL

A. Manufacturer’s Field Services:
   1. Provide when required by individual Section.
   2. Provide the following services except where indicated otherwise in individual Sections.
      a. Inspect, check and approve system installation.
      b. Supervise system start-up.
      c. Provide written report indicating that system:
         1) Has been properly installed and lubricated.
         2) Is in accurate alignment.
         3) Is free from undue stress imposed by connecting lines or anchor bolts.
         4) Has been satisfactorily operated under full load conditions.
      d. Demonstrate operation of system to the Owner’s personnel.
      e. Instruct the Owner’s personnel on operation and maintenance of system.

1.5 PROJECT CONDITIONS

A. Verify that:
   1. Excess packing and shipping bolts have been removed.
   2. Interdependent systems have been checked and are operational.
1.6 CORRECTION PERIOD

A. Provide periodic continuing warranty services as necessary to ensure proper functioning of mechanical systems after occupancy of the Project, and for a period of 1 year after date of Substantial Completion.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 STARTING OF SYSTEMS

A. Inspection:
   1. Verify that Project conditions comply with requirements.
   2. Verify that status of Work meets requirements for starting of systems.

B. Preparation:
   1. Coordinate sequence for start-up of various systems including Owner-provided equipment if any.
   2. Notify the Architect 7 days prior to start-up of each system.
   3. Have at hand during entire start-up process:
      b. Shop Drawings.
      c. Product Data.
      d. Operation and Maintenance Data.
   4. Verify that each piece of equipment has been checked for:
      a. Proper lubrication.
      b. Drive rotation.
      c. Belt tension.
      d. Control sequence.
      e. Other conditions which may cause damage.
   5. Verify control systems are fully operational in automatic mode.
   6. Verify that tests, meter readings and specific electrical characteristics agree with those specified by electrical equipment Manufacturer.
   7. Bearings:
      a. Inspect for cleanliness, clean and remove foreign materials.
      b. Verify alignment.
      c. Replace defective bearings and those which run rough or noisy.
      d. Grease as necessary and in accordance with Manufacturer's recommendations.
   8. Drives:
      a. Adjust tension in V-belt drives, and adjust vari-pitch sheaves and drives for proper equipment speed.
      b. Adjust drives for alignment of sheaves and V-belts.
      c. Clean, remove foreign materials before starting operation.
   9. Motors:
      a. Check each motor for amperage comparison to nameplate value.
      b. Correct conditions which produce excessive current flow and which exist due to equipment malfunction.
   10. Pumps:
       a. Check mechanical seals for cleanliness and adjustment before running pump.
       b. Inspect shaft sleeves for scoring.
       c. Inspect mechanical faces, chambers and seal rings; replace if defective.
       d. Verify that piping system is free of dirt and scale before circulating liquid through the pump.
       e. Check Pump Performance:
          1) Install a pressure gage on the discharge side of the check valve following pump.
          2) Operate the pump at all system operating heads.
             a) Verify pump operation with the Manufacturer's pump curve.
             b) Report deviations to the Architect.
3) Operate the pump through several cycles while observing the pressure gage.
   a) Watch pressure gage for several minutes after pump shut down.
   b) Report significant pressure variations to the Architect.
4) Remove pressure gage and plug tap.

11. Control Valves:
   a. Inspect both hand and automatic control valves; clean bonnets and stems.
   b. Tighten packing glands to ensure no leakage, but permit valve stems to operate without galling.
   c. Replace packing in valves to retain maximum adjustment after system is judged complete.
   d. Replace packing on any valve which continues to leak.
   e. Remove and repair bonnets which leak.
   f. Coat packing gland threads and valve stems with a surface preparation of "Moly-Cote" or "Fel-Pro" after cleaning.
   g. Verify that control valve seats are free from foreign material and are properly positioned for intended service.

12. Flanges:
   a. Tighten flanges after system has been placed in operation.
   b. Replace flange gaskets which show any sign of leakage after tightening.

13. Screwed Joints:
   a. Inspect screwed joints for leakage.
   b. Promptly remake each joint which appears to be faulty; do not wait for rust to form.
   c. Clean threads on both parts, apply compound and remake joints.

14. Cleaning:
   a. After system has been placed in operation, clean strainers, dirt pockets, orifices, valve seats and headers in fluid systems, to ensure being free of foreign materials.
   b. Open steam traps and air vents: remove operating elements. Clean thoroughly, replace internal parts, and put back into operation.
   c. Remove rust, scale and foreign materials from equipment and renew defaced surfaces.

15. Draft Gages: Set and calibrate draft gages of air filters and other equipment.

16. Fan Wheels:
   a. Inspect fan wheels for clearance and balance.
   b. Provide factory-authorized personnel for adjustment when needed.

17. Control Circuits: Check each electrical control circuit to ensure that operation complies with Specifications and requirements to provide desired performance.

18. Pressure gages:
   a. Inspect each pressure gage and thermometer for calibration.
   b. Replace items which are defaced, broken or which read incorrectly.

19. Repair damaged insulation.

20. Venting and drainage:
   a. Vent gases trapped in any part of systems.
   b. Verify that liquids are drained from all parts of gas or air systems.

21. Leaks: Check piping for leaks at every joint and at every screwed, flanged or welded connection using "Leak-Tek" or other approved compound.

C. Start-up:
   1. Execute start-up under supervision of responsible persons in accordance with Manufacturer's instructions.
   2. Place equipment in operation in proper sequence.

3.2 SYSTEMS DEMONSTRATION

A. Preparation:
   1. Verify That System:
      a. Has been inspected and put in service.
      b. Is fully operational.
   2. Operation and Maintenance Manuals:
      a. Completed.
      b. Sufficient copies available for use in demonstrations and instructions.
B. Demonstrations and Instructions:
   1. Demonstration Of and Instruction On Operation and Maintenance of System:
      a. To the Owner's personnel.
      b. Two weeks prior to Substantial Completion.
   2. Equipment Requiring Seasonal Operation: Demonstrate within 6 months of Substantial Completion.
   3. Instruction:
      a. Operation and maintenance manual as basis.
      b. Review contents of manual in detail.
      c. Explain all aspects of operation and maintenance.
   4. Demonstrate:
      a. Start-up.
      b. Operation.
      c. Control.
      d. Adjustment.
      e. Troubleshooting.
      f. Servicing.
      g. Maintenance.
      h. Shutdown.

3.3 PERFORMANCE TEST

A. Performance Test:
   1. Test the entire Work, including all of its individual systems for 2 weeks before final payment will be made.
   2. Make final tests in the presence of the Owner and the Architect.
   3. If any part of the Work or equipment does not meet Specifications:
      a. Correct the situation.
      b. Obtain approval of the Architect before final payment is made.
   4. Provide the personnel and bear all costs for correcting all malfunctions.
   5. The Owner will provide operating personnel and utilities.
SECTION 01 77 00 – CLOSEOUT PROCEDURES

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 instructions for and the responsibilities of each party in contract closeout.

B. Related Section includes Certificate of Substantial Completion.

1.3 SUBSTANTIAL COMPLETION

A. Contractor: When Contractor considers that the Work or any portion of the Work is ready for its intended use, Contractor shall submit:
   1. Written certification to Architect/Engineer and Owner that the Work, or designated portion of the Work, is substantially complete.
   2. A list of major items to be completed or corrected.
   3. Request that Architect/Engineer issue a certificate of Substantial Completion.

B. Architect/Engineer's Inspection: Architect/Engineer will make an inspection:
   1. Within 10 full working days after receipt of request, or on a date mutually agreed upon with all attendees.
   2. Together with Owner and Contractor.

C. Architect/Engineer's Determination of Substantial Completion:
   1. Should Architect/Engineer consider the Work or designated portion of the Work substantially complete, the following steps shall be taken:
      a. Contractor shall prepare and submit to Architect/Engineer, a list of items to be completed or corrected as determined by the inspection.
      b. Architect/Engineer will prepare and deliver to Owner:
         1) A tentative certificate of Substantial Completion.
         2) A tentative list of items to be completed or corrected before final payment.
      c. Owner shall have 7 full working days after receipt of the tentative certificate during which to make written objection to Architect/Engineer as to any provisions of the certificate or attached list.
      d. Architect/Engineer will, within 14 full working days after delivery of tentative certificate to Owner, decide:
         1) Not Substantially Complete: Architect/Engineer will issue written notice to Contractor stating reasons.
         2) Substantially Complete: Architect/Engineer will issue definitive certificate of Substantial Completion and a revised list of items to be corrected or completed.
   2. Should Architect/Engineer consider that the Work or designated portion of the Work is not substantially complete, the following steps shall be taken:
      a. Architect/Engineer shall notify Contractor in writing stating Architect/Engineer's reasons.
      b. Contractor shall complete the Work and send a second written notice to Architect/Engineer certifying that the Project, or designated portion of the Project, is substantially complete.
      c. Architect/Engineer and Owner will reinspect the Work.

D. Division of Responsibilities:
   1. Architect/Engineer:
      a. At the time of delivery of tentative certificate of Substantial Completion.
      b. Deliver to Owner and Contractor a written recommendation as to division of responsibilities pending final payment with respect to:
         1) Security.
         2) Operation.
3) Safety.
4) Protection of the Work.
5) Maintenance.
6) Heat.
7) Utilities.
8) Insurance.
9) Warranties.

2. Architect/Engineer's written recommendation on division of responsibilities shall be binding on Owner and Contractor until final payment unless Owner and Contractor agree otherwise in writing and so notify Architect prior to Architect's issuance of a definitive certificate of Substantial Completion.

1.4 FINAL INSPECTION

A. Contractor Certification: Prior to final inspection, Contractor shall submit written certification that:
   1. The Contract Documents have been reviewed.
   2. The Project has been inspected in compliance with the Contract Documents.
   3. Work has been completed in accordance with the Contract Documents.
   4. Equipment and systems have been tested in the presence of the Owner's representative and are operational.
   5. The Project is complete and ready for final inspection.

B. Architect/Engineer's Inspection: The Architect/Engineer will make final inspection:
   1. Within 10 full working days after receipt of certification.
   2. Together with Owner and Contractor.

C. Architect/Engineer's Determination of Final Completion:
   1. Should Architect/Engineer consider the Work complete and ready for final payment in accordance with the requirements of the Contract Documents, Architect/Engineer shall request Contractor to make Project closeout submittals.
   2. Should Architect/Engineer consider the Work not complete and ready for final payment:
      a. Architect/Engineer shall notify Contractor in writing stating the reasons.
      b. Contractor:
         1) Take immediate steps to remedy the stated deficiencies.
         2) Send a second written notice to Architect/Engineer certifying that the Work is complete.
      c. Architect/Engineer and Owner will reinspect the Work.

1.5 REINSPECTION COSTS

A. Should Architect/Engineer be required to perform second inspections because of failure of the Work to comply with the original certifications of Contractor, Owner will compensate Architect/Engineer for additional services and deduct the amount paid from payment or payments to Contractor, according to the Preferred Vendor agreement.

1.6 ADDITIONAL INSPECTION COSTS

A. Substantial Completion: Owner will compensate Architect/Engineer for inspection services rendered between the scheduled date of Substantial Completion and the actual date of Substantial Completion and deduct the amounts paid from payment or payments to Contractor.

B. Final Completion: Owner will compensate Architect/Engineer for inspection services rendered between the scheduled date of final completion and the actual date of final completion and deduct the amounts paid from payment or payments to Contractor.
1.7 CLOSEOUT SUBMITTALS

A. Contractor:
   1. Provide closeout submittals as required in the Contract Documents.
   2. These submittals shall include, but not necessarily be limited to:
      a. Project record documents.
      b. Operation and maintenance manuals.
      c. Guarantees.
      d. Spare parts and maintenance materials.
      e. Instruction in operation of all systems.
         1) Record all training per WSU standards and create DVD. Provide two copies with close-out documentation.

1.8 EVIDENCE OF PAYMENTS AND RELEASE OF LIENS

A. Affidavits:
   1. Submit with final Application for Payment an affidavit of payment of debts and release of claims.
   2. Affidavit shall include:
      a. Contractor's release or waiver of lien.
      b. Consent of surety of final payment.
      c. Separate releases or waivers of liens for Subcontractors, Suppliers and others with lien rights against property of Owner together with a list of those parties.

B. Execution: All submittals shall be duly executed before delivery to Architect/Engineer.

1.9 FINAL ADJUSTMENT OF ACCOUNTS

A. Final Statement: Submit a final statement of accounting, which reflects all adjustments, to Architect/Engineer.
   This statement shall contain the following:
   2. Additions and deductions.
   3. Total Contract Price as adjusted.
   4. Previous payments.
   5. Sum remaining due.

B. Final Change Order: Architect may prepare a final Change Order reflecting approved adjustments to the Contract Price not previously made by Change Orders.

1.10 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit a final Application for Payment in accordance with the requirements of the Contract Documents.

B. Disposition of Final Application for Payment:
   1. If the final Application for Payment and the Work are acceptable in accordance with the Contract Documents:
      a. Architect/Engineer, within 10 full working days after receipt of the Application for Payment:
         1) Submit to Owner a written recommendation for payment.
         2) Submit to Owner and Contractor a written notice that the Work is acceptable subject to the provisions of the General Conditions.
      b. Owner will, within 30 calendar days after receipt of the Application for Payment and Architect/Engineer's recommendation in accordance with the Contract Documents, pay to Contractor the amount recommended.
   2. If the Application for Payment, the Work or both are unacceptable:
      a. Architect/Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment.
      b. Contractor shall make the necessary corrections and resubmit the Application for Payment.
3. Final Completion Delayed:
   a. Upon receipt of Contractor's final Application for Payment and recommendation by Architect/Engineer, Owner shall make payment of the balance due for that portion of the Work fully completed and accepted if Architect/Engineer confirms that final completion of the Work is significantly delayed through no fault of Contractor.
   b. Payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.
   c. Contractor shall submit with the Application for Payment written consent of surety if the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement.

PART 2 - PRODUCTS
Not used.

PART 3 - EXECUTION
Not used.

END OF SECTION 01 77 00
SECTION 01 78 39 – PROJECT RECORD DOCUMENTS

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 procedures for the maintenance, recording and submittal of Project record documents.

1.3 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Storage:
   1. Store documents and Samples in Contractor's field office apart from documents used for construction.
   2. Provide files and racks for storage of documents.
   3. Provide locked cabinet or secure storage space for storage of Samples.

B. Filing: File record documents in accordance with CSI Masterformat.

C. Maintenance:
   1. Maintain documents in a clean, dry, legible condition and in good order.
   2. Do not use record documents for construction purposes.

D. Availability: Make documents and Samples available at all times for inspection by Architect.
   1. Reviewed submittals and shop drawings to be maintained on a FTP site accessible to project team members.

1.4 RECORDING

A. Labeling: Label each document "PROJECT RECORD" in neat large printed letters.

B. Recording:
   1. Record actual revisions to the Work.
   2. Record information concurrently with construction progress.
   3. Do not conceal any work until required information is recorded.

C. Drawings:
   1. Legibly mark, with notes or graphic representations, to record actual construction.
      a. Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.
      b. Field changes of dimension and detail.
      c. Changes made by Field Order, Work Change Directive or Change Order.
      d. Details not on original Contract Drawings.
   2. After Architect/Engineer's review of the record drawings, transfer all marks to electronic documents provided by Architect/Engineer.

D. Specifications and Addenda:
   1. Legibly mark each Section to record:
      a. Manufacturer, trade name, catalog number, and Supplier of each Product and item of equipment actually installed.
      b. Changes made by Field Order, Work Change Directive or Change Order.
1.5 SUBMITTAL

A. Delivery: At Contract closeout, deliver record documents to Architect/Engineer for Owner.
   1. Provide electronic as well as 3 hard copies.
   2. Provide two copies of DVDs recorded of all training per WSU standards.

B. Transmittal Letter:
   1. Accompany submittal with transmittal letter in duplicate, containing:
      a. Date.
      b. Project title and number.
      c. Contractor's name and address.
      d. Title and number of each Record Document.
      e. Signature of Contractor or their authorized representative.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 78 39
SECTION 02 41 19 – SELECTIVE DEMOLITION

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 modification, alteration, conversion, and renovation of existing structures:
1. Be aware of the many incidental items which exist which must be demolished, relocated, or replaced in order to accomplish the remodeling work of trades.
2. Include the price of such demolition, relocating, and replacement in the base Bid.
3. These incidental items may or may not be indicated in the Contract Documents.
4. Contractor and Subcontractors performing remodeling work are expected to be familiar with the unknown nature of existing utilities serving an area to be remodeled and shall calculate the base Bid to include the demolition, removal, relocation, and replacement of these utilities.
5. Contractor to perform a walk-through with the Owner to review any requested salvaged items prior to demolition.
6. The Owner will perform testing for asbestos containing materials and perform any necessary abatement prior to the start of construction.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the pertinent provisions of the following:
2. ASTM: D1557 - Laboratory Compaction Characteristics of Soil Using Modified Effort.

1.4 DEFINITIONS

A. Terms:
1. Abandon:
   a. Remove an item to the extent that it is not visible and does not interfere with new construction.
   b. Portions of the abandoned item may be left in place.
   c. No abandoned items shall be left below new footings.
2. Demolish:
   a. Remove existing items from their present location in the Project area and haul to an area outside of the Project area.
   b. Remove utilities serving these items.
3. Relocate:
   a. Move existing items from their present location to another location in the Project area.
   b. Extend utilities serving the present location to the new location.
4. Remove:
   a. Except for items indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner’s property, demolished materials shall become Contractor’s property.
   b. Remove existing items from their present location in the Project area and haul to an area outside of the Project area.
   c. Remove utilities serving these items.
5. Replace:
   a. Remove existing items from their present location in the Project area, haul them to an area outside of the Project area, and furnish and install new items in the same or another location.
   b. Extend utilities serving the present location to the new location.
6. Reuse: Move existing items from their present location to another location in the Project area. Extend utilities serving the present location to the new location.
1.5 DIVISION OF WORK

A. Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of the work:

1. Contractor:
   a. Cut and patch walls, floors, and ceilings to allow for recessed utilities and ductwork.
   b. Remove and reinstall existing suspended ceilings to allow for above ceiling construction.
   c. Replace damaged units.
   d. Install new ceilings as indicated on the Drawings.
   e. Place sleeves in new concrete structures.
   f. Install fire stop and smoke stop systems at penetrations for ratings indicated in accordance with local building codes.

2. Mechanical, Electrical, and Fire Protection Subcontractors:
   b. Install fire stop and smoke stop systems at utility penetrations in accordance with local building codes.
   c. Furnish and install sleeves in gypsum board and masonry construction.
   d. Core drill existing concrete for new utilities and sleeves after obtaining Architect’s review of locations.
   e. Remove and reinstall existing fire protection heads to allow for ceiling removal and installation.
   f. Furnish new heads, piping, and connections as required for completion of the Work.

3. Miscellaneous:
   a. Each trade shall be financially responsible for cutting and patching for sleeves, penetrations, and installation of isolated components as necessary for its work unless herein specifically stated to the contrary.
   b. On renovation projects, cut and patch walls, floors, and ceilings to allow for continuous runs of recessed utilities and ductwork.
   c. Patching shall be done by the trade whose work is damaged.
   d. Costs caused by defective or ill-timed work shall be borne by the party responsible.
   e. Each trade shall do fitting of its own work as required to make its several components fit together or to receive the work of other trades.

1.6 QUALITY ASSURANCE

A. Qualifications: Engage an experienced firm that has specialized in demolition work similar to material and extent indicated for this Project.

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

C. Pre-Demolition Conference:
   1. Conduct pre-demolition conference at Site in accordance with in Division 01 Section “Project Meetings.”
   2. Review methods and procedures related to selective demolition including, but not limited to, the following:
      a. Inspect and discuss condition of construction to be selectively demolished.
      b. Review structural load limitations of existing structure.
      c. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and to avoid delays.
      d. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
1.7 PROJECT CONDITIONS

A. Owner Occupancy:
   1. Owner will occupy portions of building immediately adjacent to selective demolition area.
   2. Conduct selective demolition so Owner's operations will not be disrupted.
   3. Provide not less than 72 hours notice to Owner of activities that will affect Owner's operations.

B. Access:
   1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
   2. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.

C. Conditions:
   1. Owner and Architect assume no responsibility for condition of areas to be selectively demolished.
   2. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as far as practicable.
   3. Before selective demolition begins, Owner will remove the following items:
      a. Furnishings and fixtures.
      b. Movable equipment.

D. Storage or sale of removed items or materials on Site will not be permitted.

E. Maintenance of Utilities:
   1. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   2. Maintain fire-protection facilities in service during selective demolition operations.

F. Known Hazardous Materials:
   1. The Owner has tested for hazardous materials and they are present in building to be selectively demolished.
   2. Hazardous materials remediation is the responsibility of the Owner.
   3. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.

1.8 WARRANTIES

A. Existing Warranties:
   1. Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.
   2. If possible, retain original installer or fabricator to patch exposed work that is damaged during selective demolition.
   3. If it is not possible to engage original installer or fabricator, engage another recognized, experienced, and specialized firm.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Materials and workmanship shall conform to the requirements of other Sections of the Specifications.
   2. Where no materials are specified in these specifications, use materials of an equivalent type, quality, and size to match those existing in other areas of the facility.
   3. If none exist, use materials and workmanship recognized as of the highest quality in the industry.
   4. Obtain Architect's review of such material and workmanship.

B. Piping: Existing piping which is removed from its present location shall not be reused where new piping is required unless specifically noted on the Drawings.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Inventory and record the condition of items to be removed and reinstalled, and of items to be removed and salvaged.

D. Conflicts:
   1. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict.
   2. Promptly submit written report to Engineer.

E. Survey, or engage a competent person to survey condition of the building, in accordance with requirements of OSHA, to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition operations.

F. Perform additional surveys as the work progresses to detect hazards resulting from operations to date.

3.2 UTILITY SERVICES

A. Maintain existing services indicated to remain and protect them against damage during selective demolition operations.

B. Interruptions:
   1. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and other authorities having jurisdiction.
   2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.
   3. Provide at least 72 hours notice to Owner if shutdown of service is required during changeover.

C. Utility Requirements:
   1. Locate, identify, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.
   2. Owner will arrange to shut off indicated utilities when requested by Contractor.
   3. Arrange to shut off indicated utilities with utility companies.
   4. If utility services are required to be removed, relocated, or abandoned, before proceeding with selective demolition, provide temporary utilities that bypass areas of selective demolition and that maintain continuity of service to other parts of building.
   5. Cut off pipe or conduit in walls or partitions to be removed.
   6. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

3.3 PREPARATION

A. Dangerous Materials: Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.

B. Site Access and Temporary Controls:
   1. Conduct selective demolition and debris removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   2. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and other authorities having jurisdiction.
   3. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
   4. Erect temporary walls for protection and separation where required by authorities having jurisdiction.
C. Temporary Facilities:

1. Protection:
   a. Provide temporary barricades and other protection required to prevent injury to people and
damage to adjacent areas.
   b. Provide protection to ensure safe passage of people around selective demolition area, and to and
from occupied portion of building.
   c. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed
during selective demolition operations.
   d. Cover and protect furniture, furnishings, and equipment that have not been removed.

2. Shoring and Bracing:
   a. Provide and maintain shoring, bracing, or structural support to preserve stability and prevent
movement, settlement, or collapse of construction to remain, and to prevent unexpected or
uncontrolled movement or collapse of construction being demolished.
   b. Strengthen or add new supports when required during progress of selected demolition.

3.4 POLLUTION CONTROLS

A. Dust Control:
   1. Use water mist, temporary closures, and other suitable methods to limit spread of dust and dirt.
   2. Do not use water when it may damage existing construction or create hazardous or objectionable
conditions, such as ice, flooding, and pollution.
   3. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosure.
   4. Vacuum carpeted areas.
   5. Comply with governing environmental protection regulations.

B. Disposal:
   1. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   2. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris
to grade level in a controlled descent.

3.5 GENERAL

A. Demolish and remove existing construction only to the extent required by new construction and as indicated.

B. Burn permit required by WSU Office of Risk Management in advance of any burning, grinding, (etc) work.

C. Methods:
   1. Use methods required to complete the work within limitations of governing regulations.
   2. Level by Level:
      a. Proceed with selective demolition systematically, from higher to lower level.
      b. Complete selective demolition operations above each floor or tier before disturbing supporting
members on the next lower level.
   3. Cutting Openings:
      a. Neatly cut openings and holes plumb, square, and true to dimensions required.
      b. Use cutting methods least likely to damage construction to remain or to adjoining construction.
      c. Use hand tools or small power tools designed for sawing or grinding, not hammering and
chopping, to minimize disturbance of adjacent surfaces.
      d. Temporarily cover openings to remain.
   4. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished
surfaces.
   5. Flame Cutting:
      a. Do not use cutting torches until work area is cleared of flammable materials.
      b. At concealed spaces, such as duct and pipe chases, verify condition and contents of hidden space
before starting flame-cutting operations.
      c. Maintain fire watch and portable fire suppression devices during flame-cutting operations.
      d. Maintain adequate ventilation when using cutting torches.
   6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials, and promptly and
legally dispose of off Site.
   7. Locate selective demolition equipment and remove debris and materials so as not to impose excessive
loads on supporting walls, floors, or framing.
8. Dispose of demolished items and materials promptly.
9. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.

D. Existing Facilities: Comply with Owner’s requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during the selective demolition operations.

E. Removed and Salvaged Items:
1. Clean salvaged items.
2. Pack or crate items after cleaning and identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner’s storage area designated by Owner.
5. Protect items from damage during transport and storage.

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

G. Existing Items to Remain:
1. Protect construction indicated to remain against damage and soiling during selective demolition.
2. When permitted by Architect, items may be removed to a suitable, protected storage location and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 DEMOLITION

A. Structures:
1. Cut, repair, reuse, excavate, demolish or otherwise remove parts of the existing structures or appurtenances, as indicated on the Drawings, herein specified and necessary to permit completion of the Work.
2. Dispose of demolished materials in an approved manner.
3. Include necessary cutting, bending, and welding of reinforcing steel, structural steel, or miscellaneous metal work found embedded in the existing structures.
4. When removing materials or portions of existing structures, shore up, underpin, and protect adjacent structures.
5. Concrete:
   a. Demolish in small sections.
   b. Cut concrete to a depth of at least 3/4-inch at junctures with construction to remain, using a power driven saw.
   c. Dislodge concrete from reinforcement to remain at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated.
   d. Neatly trim openings to dimensions indicated.
6. Engineer's review of cutting: No existing structure, equipment or appurtenance shall be shifted, cut, removed or otherwise altered without obtaining review of Engineer.

B. Equipment:
1. Dismantle, remove, and relocate existing equipment, piping, and other appurtenances required for the completion of the Work.
2. Cut existing pipelines for the purpose of making connections thereto.
3. Cut off anchor bolts for equipment and structural steel indicated to be removed 1-inch below the concrete surface.
4. Patch remaining concrete surface to smooth even finish.
5. Remove air conditioning equipment without releasing refrigerants, if applicable.
C. Piping, Fire Protection, and Electrical Components:
   1. When a new connection is made to an existing pipeline, install additional new piping, extending to and including the most convenient new valve.
   2. Piping, conduit, and wiring indicated or required to be demolished shall be done so to the nearest reasonable connection outside of the Project area or as directed by Engineer.
   3. Where necessary or required for the purpose of making connections, cut existing pipelines in a manner to provide an approved joint.
   4. Weld beads, flanges, and provide Dresser couplings on existing and new piping.
   5. Remove and reinstall existing fire protection heads to allow for new construction.
   6. Comply with applicable fire protection codes.
   7. Furnish new heads, piping, and connections as required for completion of the Work.
   8. Remove junction boxes and electrical outlets which will no longer be in use.
   9. At existing walls which are made thicker, extend piping and wiring to accommodate additional wall thickness.
   10. Remove and reinstall fixtures and electrical outlets, switches, etc.

D. Ductwork:
   1. Remove portions of existing ductwork systems to the nearest branch outside the project area, except as indicated otherwise on drawings.
   2. Remove existing ductwork in a manner to minimize dispersion of dust in the duct system.
   3. Repair and replace existing insulation and duct liner disturbed by this Work to provide a continuous smooth surface.
   4. New connections to existing ductwork shall comply with the requirements of Division 23 Section “Metal Ducts.”

E. Masonry Walls: Where masonry walls are to be removed and replaced, and where filling existing openings, allow for toothing in of the new masonry at alternate courses so that the existing running bond pattern is maintained.

F. Floor Slabs:
   1. Where new utilities must be installed below the existing floor slab, saw cut the slab for at least 1-inch of depth.
   2. Break out the remaining depth with jack hammers or hand tools to provide a rough surface.
   3. Leave existing steel reinforcing so that it laps at least 6 inches into the new concrete slab over the trench.
   4. The exact width of the concrete removed shall depend upon the required depth and diameter of the new utility.
   5. Allow for sufficient working space in the trench.

G. Conceal Utilities: Recess new piping, conduit, and other utilities into floors, wires, and ceilings in finished areas.

H. Ownership of Salvaged Materials:
   1. Materials and equipment removed shall remain the property of Owner at Owner's option.
   2. Items not salvageable, as determined by Architect and Owner, and items Owner elects not to keep shall become the property of Contractor to be properly disposed of off the Site.
   3. Salvaged equipment shall be thoroughly cleaned, lubricated, and greased for protection during prolonged storage.

I. Nonshrink Grout: Use nonshrink grout for setting wall castings, sleeves, leveling pump bases, doweling anchors into existing concrete and elsewhere as indicated.

J. Protect Facility from Water Damage: Provide flumes, hoses, piping, suitable plugs, bulkheads, or other means to divert or hold back the flow of wastewater, water, or other liquids, as required for proper performance of the Work.

K. Blasting: Not permitted.
L. Sleeves:
1. Subcontractors for mechanical, electrical, and other trades shall furnish sleeves and inserts for pipes, conduits, and similar items in forms, walls, partitions, and floors.
2. Perform work in cooperation with Contractor.
3. Place items in ample time so as not to delay operations.
4. Do not place sleeves so they pass through beams, girders, and similar construction.

M. Firestopping and Smokestopping: Install firestop and smokestop systems at utility penetrations in accordance with local building codes and Division 07 Section “Penetration Firestopping”.

N. Miscellaneous: At existing walls which are made thicker, reinstall fire extinguisher cabinets, clocks, thermostats, and other wall hung items in new wall to accommodate additional wall thickness.

3.7 PATCHING AND REFINISHING

A. Promptly repair damage to adjacent construction caused by selective demolition operations.

B. Patching:
1. Patch and repair existing surfaces from which items have been removed leaving holes, fasteners, and surface blemishes exposed to view.
2. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
3. Completely fill holes and depressions in existing masonry walls that are to remain with an approved masonry patching material applied according to Manufacturer’s written recommendations.
4. Comply with Division 01 Section “Cutting and Patching.”

C. Refinishing:
1. Prepare existing surfaces for finishes by scraping, sanding, filling, acid etching, and sand blasting to ensure bonding and a smooth finish.
2. Refinish entire surfaces as necessary to provide an even finish.
3. Refinish continuous surfaces to the nearest intersection and entirely finish assemblies.
4. Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.
5. Refinish entire surfaces if necessary to remediate existing lead painted surfaces.

D. Floors and Walls:
1. Where floors or partitions that are demolished extend one finished area into another, patch and repair floor and wall surfaces in the new space.
2. Provide an even surface of uniform finish, color, texture, and appearance.
3. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
4. Patch with durable seams that are as invisible as possible.
5. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
6. Where patching occurs in a painted surface, apply primer and intermediate coats over the patch and apply final coat over entire unbroken surface containing patch.
7. Provide additional coats until patch blends with adjacent surfaces.
8. Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

E. Ceilings: Patch, repair, or rehang existing materials as necessary to provide even plane surface of uniform appearance.

3.8 CLEANING

A. Clean materials installed under this Section in accordance with Division 01 Section “Cleaning and Waste Management.”

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

END OF SECTION 02 41 19
SECTION 02 42 13 - REMOVAL OF EXISTING 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: the removal of existing equipment and all pipe, fittings, valves and appurtenances not required for the proper operation of the project.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 GENERAL

A. Do not proceed with removal of any equipment, piping or appurtenances without specific approval of Engineer. All equipment, piping or appurtenances removed without proper authorization, which is necessary for the operation of the existing facility, shall be replaced to the satisfaction of Engineer at Contractor's expense.

B. All existing tubing, insulation, hangers and supports shall become the property of Contractor immediately upon removal from their present locations. Contractor shall remove such material from the Site at his own expense and it shall not be reused.

C. All existing valves, and other special piping and utility elements, greater than 3-inch diameter, removed shall remain the property of Owner. Contractor shall furnish all labor and material to identify, clean, protect, crate and box and store them at the Site.

D. Provide pieces of equipment weighing 150 pounds or more with suitable skids before storing.

E. Wherever piping is removed, adjacent pipe and headers that are to remain in service shall be blanked off or plugged and then anchored in an approved manner.

F. Equipment to be retained by Owner shall be carefully removed from the present location, cleaned and immediately stored onsite as designated by Owner, [ or as specified in Division 02 Section “Packaging and Storage of Existing Equipment” ].

G. Take all necessary precautions against damaging the material and equipment to be stored. Repair all damage resulting from Contractor operations, as directed by and to the satisfaction of Engineer.

H. Give itemized lists of materials removed and stored to Engineer daily. A final typed itemized list shall be furnished to Engineer in 6 copies at the completion of construction. The list shall include items, method of packaging, and place of storage.

3.2 EQUIPMENT TO BE RETAINED

A. The following is a list of items which shall be removed and remain the property of Owner. The list is not intended to be complete, but only to convey the general types of equipment to be retained by Owner:
   1. Electric panels and motor control centers.
   2. Pumps and drive units.
   3. Flow meters.
4. Primary and final settling tank mechanisms.
5. Pipes and valves greater than 3-inch diameter (not including buried pipes and valves).
7. Air compressors.
8. Blowers and motors.

B. All equipment removed shall remain the property of Owner unless designated otherwise by Owner.

C. If Owner elects not to retain ownership of certain items, the items shall be removed from the site and disposed of properly by the Contractor at the Contractor's expense.

END OF SECTION 02 42 13
SECTION 03 01 33 – FIBER REINFORCED COMPOSITE CONCRETE

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 reinforcement of existing structural concrete elements with fiber reinforced composite systems.

B. Fiber composite work will be paid for on a Lump Sum basis.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ACI:
      b. 503R – Pull Off Test to Determine CFRP Adhesive to Concrete Substrate.
   2. International Concrete Repair Institute (ICRI).

1.4 DEFINITIONS

A. CFRP: Carbon fiber reinforced plastic.

1.5 SUBMITTALS

A. Shop Drawings: Submit complete Shop Drawings for each installation of the fiber reinforced composite system. The Shop Drawings shall contain details of the number and thickness of layers, joint and end details, and locations to be applied.

B. Product Data:
   1. Include specifications and recommended application procedures showing compliance with the project requirements.
   2. Provide SDS safety data sheets for products used.
   3. Provide either an approved ICBO Evaluation Report number in the name of the system and system's Manufacturer, or an evaluation by independent testing facility.
   4. Product Suitability:
      a. Submit signed letter from Product Manufacturer's technical representative stating that they have visited the Site, reviewed conditions and agree that the products specified are suitable for this application.
      b. The letter shall certify that the Product Manufacturer's technical representative:
         1) Is familiar with the project, aware of job conditions and aware of associated products (i.e., sealants, concrete repair products and other proposed for the Project).
         2) Agrees with the intended application of their products as specified.
         3) Agrees with the surface preparation specified.
         4) Agrees with project specifications. If necessary, submit revisions to project specifications.
         5) Agrees that their product is compatible with associated products (i.e., sealants, concrete repair materials and other proposed for the Project).
         6) Agrees with the type and quantity of testing specified to ensure their product is adequately installed.
   5. Design Data: Submit calculations for the composite system for approval by Engineer, stamped by a structural engineer licensed in the location of the Work. Calculations shall conform to ACI 440.2R-02.
C. Surface Preparation Method: Submit details of preparation method to Engineer for review prior to commencing work.

D. CFRP’s Project Record: Applicator shall keep a detailed record of coating application areas and submit to Engineer.

1.6 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.
   3. Each component of a system or product shall be installed by Manufacturer trained personnel. Installers shall demonstrate knowledge of product and installation.

B. Manufacturer’s Services:
   1. Provide a minimum of 1 day of product Manufacturer’s technical representative during the preparation for and installation of the carbon fiber reinforced plastic (CFRP). Review the work to be performed with the applicator.

C. CFRP’s Supervising Site Representative:
   1. On Site during work being performed.
   2. Knowledgeable in all aspects of the Work.
   3. Review each day’s agenda with crew, Contractor’s and Engineer’s Site representatives.
   4. If a portion of the Work becomes unclear as to the most appropriate direction, work shall stop until a consensus is reached by all parties, including the Engineer’s representative and the Manufacturer’s technical representative as required.

D. Mock-ups:
   1. Complete mock-ups of carbon fiber reinforcement.
   2. Obtain Engineer’s and Owner’s approval of mock-up prior to continuing.
   3. Mock-ups may be completed as part of Contract Work upon approval of the Engineer.

E. Testing:
   1. CFRP Testing: The Owner shall retain the services of a qualified testing agency to perform the pull off tests for the CFRP as part of the Base Bid. Locations and number of tests shall be as recommended by the CFRP Manufacturer.
   2. The adhesive strength of the concrete repair at CFRP locations shall be verified after preparation by random pull-off testing (ACI 503R) at the direction of the Engineer. Minimum tensile strength shall be 200 psi with concrete substrate failure; or as approved by the Engineer.

1.7 TEMPORARY HEATING, VENTILATION AND HUMIDITY CONTROL DESIGN AND PERFORMANCE REQUIREMENTS

A. The Installation Contractor or a Specialty Contractor shall provide temporary/mobile air temperature, humidity and ventilation control during the course of this project.

B. Provide additional equipment and fuel as required to condition the space for surface preparation, application of products, and curing of those products, in accordance with Manufacturer’s requirements. This equipment may include, but not be limited to, dehumidification, heaters, and fans for intake and exhaust air.

C. Contractor shall not use Owner’s electrical power for temporary/mobile air system.

1.8 WARRANTY

A. All material under this section shall be fully warranted for a period of one year against any defects in materials or workmanship commencing with the date of Substantial Completion.
B. All required warranties shall be obtained by the Contractor as an agent for the Owner from all installation contractors, and the manufacturers. All such warranties shall inure to the benefit of the Owner without the necessity of separate transfer or assignment thereof.

C. Responsibilities of Each Party
   1. Contractor: Shall act as the agent for the Owner in collecting and enforcing submission of the warranty requirements prior to Substantial Completion of the project.
   2. Installation Contractor: Responsible for 100% of the labor to remove and replace the defective material if a failure occurs within the warranty period.
   3. Manufacturer: Responsible for supplying 100% of replacement material in case of a failure during the warranty period unless stated otherwise in the warranty.

D. Specific Warranty Requirements
   1. The one-year comprehensive warranty shall specifically cover the following:
      a. A fully complete 100% warranty for all workmanship and material for the repairs.
      b. Delamination of the coating or substrate.
      c. Any damage to material or equipment caused by coating system failure.
      d. Failures due to improper surface preparation, use of non-approved materials, insufficient thickness for any part of the system including primer(s), faulty workmanship, or non-approved deviations from current manufacturer’s specifications and written instructions.
      e. Material incompatibility with any existing coating.

E. Replacement Cost:
   1. The warranty shall cover 100% of the replacement cost whether or not the Owner has benefitted from use of the product through part of its useful life.
   2. When the work covered by the warranty has failed, the replacement work shall be warranted to cover the original remaining warranty period.

F. Work by Owner:
   1. The Owner agrees to empty the space of product at a convenient time which will cause the least interference or disruption of the Owner’s operations. The Manufacturer and the installation contractor agree to perform the repair work at a time convenient to the Owner.
   2. Manufacturer and the installation contractor shall take all necessary actions required to further clean and repair any space receiving the repair work. The Owner is not responsible for any cleaning or preparation beyond emptying the space.

PART 2 - PRODUCTS

2.1 MATERIALS

A. VOC Compliance:
   1. All individual coatings and coating systems shall have VOC levels at or below the EPA recommendations identified in 40 CFR Part 59.
   2. VOC content shall be tested in accordance with EPA Method 24.

B. Fiber Reinforced Composite Systems:
   1. Sika Carbodur System by Sika Corporation.
   2. Tyfo Fiberwrap System by Fyfe Co. LLC.
   3. Fiber Reinforced Polymer by Simpson Strong Tie.
   4. Provide other materials as needed for the proper installation of the complete composite system as selected by the Contractor in conformance with these Specifications.

C. General: Provide primers as required in accordance with Manufacturer’s recommendations.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation: Install products in strict accordance with Manufacturer’s recommendations.
B. Install and cure products prior to cutting indicated penetrations through concrete.

C. Waste Removal: Remove waste material from Site and dispose of legally.

3.2 FIBER REINFORCED COMPOSITE SYSTEMS REPAIRS

A. General:
1. Manufacturer shall provide the services of a registered structural engineer to perform the design of the CFRP system.
2. Design requirements will be furnished to the Manufacturer by the Engineer.
3. Approximate locations of CFRP system is indicated on the Drawings.
4. The surface to receive composite shall be free from fins, sharp edges and protrusions that will cause voids behind the installed composite or that, in the opinion of Engineer, will damage the fibers. Existing uneven surfaces to receive composite shall be filled with epoxy filler or other material approved by Engineer. The contact surfaces shall have no free moisture on them at the time of application.
5. Round off sharp and chamfered corners to radius of 1-inch (±0.25-inch) by means of grinding or forming with the system’s thickened epoxy. Variations in the radius along the edge shall not exceed 1/2-inch for every 12 inches of length.
6. Surfaces shall be prepared for bonding by means of abrasive blasting or grinding to achieve a 1/16-inch minimum amplitude. Contact surfaces shall then be cleaned by hand or compressed air. One prime coat of the Manufacturer's epoxy shall be applied. Prior to the application of the saturated composite fabric, fill uneven surfaces with the Manufacturer's thickened epoxy. Provide anchorage as required by the Manufacturer, but as a minimum, as indicated on the Drawings.
7. Verify ambient and concrete temperatures. No work shall proceed if the temperature of the concrete surface being repaired is less than 35 degrees F or greater than 100 degrees F. The temperature of the epoxy components shall be between 35 and 100 degrees F at the time of mixing or as specified on the component labels. When air temperature is outside the prescribed range, other measures must be employed to ensure component’s temperature is maintained within this range.
8. Prepare the epoxy matrix by combining components at a weight (or volume) ratio specified on the Manufacturer’s labeled units, with an allowable tolerance as specified by the Manufacturer. The components of epoxy resin shall be mixed with a mechanical mixer until uniformly mixed, typically 5 minutes at 400-600 rpm. Components which have exceeded their shelf life (as designated on the material label) shall not be used.
9. Saturation of the fabric shall be performed and monitored according to Manufacturer’s specified fiber-resin ratio. A previously calibrated saturator can be used to achieve the specified ratio. Fabric shall be completely saturated prior to application to contact surface in order to ensure complete impregnation of fabric. Saturation shall be supervised and checked by the properly trained representative of the installer.
10. Clean the CFRP laminate (roughened side) with an appropriate cleaner (e.g., acetone). Dry CFRP laminate with a clean rag.
11. Apply the mixed epoxy resin onto the CFRP laminate with a “roof-shaped” spatula to a nominal thickness of 1/16-inch (1.5 mm).
12. Within the open time of the epoxy, depending upon the temperature, place the CFRP laminate onto the concrete surface. Using a hard rubber roller, press the laminate into the epoxy resin until the adhesive is forced out on both sides. Remove excess adhesive.
13. Curing: The external reinforcement shall not be disturbed for a minimum of 24 hours.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Engineer: Check work.

B. Promptly make corrections, changes, and additions required by Manufacturer's engineer.

3.4 CLEANING

A. Clean materials installed under this Section in accordance with Division 01 Section "Cleaning and Waste Management."

END OF SECTION 03 01 33
SECTION 07 84 13 – PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Penetrations in fire-resistance-rated walls.
   2. Penetrations in horizontal assemblies.
   3. Penetrations in smoke barriers.

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. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

   1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

   1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.

   2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

      a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

         1) UL in its "Fire Resistance Directory."

         2) Intertek Group in its "Directory of Listed Building Products."

         3) FM Global in its "Building Materials Approval Guide."
2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. 3M Fire Protection Products.
      b. Hilti, Inc.
      c. Tremco, Inc.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
   1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
   1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
   2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
   3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.
   1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.

F. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content:
   1. Sealants: 250 g/L.
   2. Sealant Primers for Nonporous Substrates: 250 g/L.
   3. Sealant Primers for Porous Substrates: 775 g/L.

G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

C. Install forming 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.
   1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
D. Install fill materials by proven techniques to produce the following results:
   1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
   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 the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.2 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
   1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
   2. Contractor's name, address, and phone number.
   3. Designation of applicable testing and inspecting agency.
   4. Date of installation.
   5. Manufacturer's name.
   6. Installer's name.

3.3 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 07 84 13
SECTION 07 92 00 – JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Urethane joint sealants.
   2. Mildew-resistant joint sealants.
   3. Latex joint sealants.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint sealant product.

B. Samples: For each kind and color of joint sealant required.

C. Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Preconstruction laboratory test reports.

C. Preconstruction field-adhesion-test reports.

D. Field-adhesion-test reports.

E. Sample warranties.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with glazing and gasket materials.

1.7 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. BASF Construction Chemicals - Building Systems; Sonalastic TX1.
      c. ER Systems, an ITW Company; Pacific Polymers Elasto-Than 230 MP.
      d. Pecora Corporation; Dynatrol I-XL.
      e. Polymeric Systems, Inc.; Flexiprene 1000.
      f. Sika Corporation U.S.; Sikaflex Textured Sealant.
      g. Tremco Incorporated; Dymonic.

2.3 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Corning Corporation; 786-M White.
      b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS1700 Sanitary.
      c. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex Sil 100 WF.
      d. Soudal USA; RTV GP.
      e. Tremco Incorporated; Tremsil 200.

C. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. BASF Construction Chemicals - Building Systems; Sonolac.
      c. Pecora Corporation; AC-20.
      d. Tremco Incorporated; Tremflex 834.

2.4 JOINT-SEALANT BACKING

A. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BASF Construction Chemicals - Building Systems.
      b. Construction Foam Products, a division of Nomaco, Inc.
B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.5 MISCELLANEOUS MATERIALS

A. Primer: Material 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.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - PRODUCTS

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove laitance and form-release agents from concrete.
   2. 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.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces.

3.2 INSTALLATION OF JOINT SEALANTS

A. General: Comply with ASTM C 1193 and joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Install sealant backings of kind 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.

C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

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 in 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 to form smooth, uniform beads of configuration indicated. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   1. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
3.3 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Locations:
      a. Control and expansion joints on exposed interior surfaces of exterior walls.
      b. Tile control and expansion joints.
      c. Vertical joints on exposed surfaces of unit masonry, concrete, walls, and partitions.
      d. Other joints as indicated on Drawings.
   2. Joint Sealant: Urethane, S, NS, 25, NT.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
   1. Joint Locations:
      a. Control joints on exposed interior surfaces of exterior walls.
      b. Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.
      c. Other joints as indicated on Drawings.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Locations:
      a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
      b. Tile control and expansion joints where indicated.
      c. Other joints as indicated on Drawings.
   2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

D. Joint-Sealant Application: Concealed mastics.
   1. Joint Locations:
      a. Aluminum thresholds.
      b. Sill plates.
      c. Other joints as indicated on Drawings.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 07 92 00
SECTION 08 11 13 – HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Extent of steel doors and frames is indicated on drawings and in schedules.
B. Types of hollow metal work includes:
   1. Steel doors.
   2. Steel door frames.
   3. Steel window frames.

1.3 SUBMITTALS
A. Product Data: Mfr's standard details and specifications for steel doors and door and window frames.
B. Shop Drawings: Indicate application of products to project.

1.4 QUALITY ASSURANCE
A. Standards: Comply with Steel Door Institute (SDI-100-91) "Recommended Specifications for Standard Steel Doors and Frames" for materials quality, metal gages, and construction details for Grades and Models indicated in Part 2 of this Section, and shall meet ANSI Grade A requirements

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
   1. Amweld Building Products, Inc.
   2. Ceco Corp.
   3. Curries Co.
   5. Republic Builders Products

2.2 STEEL DOORS AND FRAMES
A. Materials: Steel doors and frames; hot-rolled, pickled and oiled per ASTM A 569 and A 568; cold-rolled per ASTM A 366 and A 568.

B. Steel Doors, General: Provide doors complying with material and construction requirements of ANSI/SDI-100 for the indicated Grades and Models:
   1. Grade II, heavy-duty (Level B); 1-3/4-inch thick; min. 18 gage face sheets.
   2. Model 3, Seamless - Hollow Steel Construction; or Model 4, Seamless - Composite Construction as standard with door manufacturer or to comply with other specified requirements of this Section.

C. Steel Frames, General: Provide frames complying with material and construction requirements of ANSI/SDI-111A, and as follows:
   1. Metal Thickness: Min. 16 gage.
   2. Type: Welded (masonry walls and partitions).
D. Fire-rated Assemblies: Provide units that are labeled and listed for rating indicated, by Underwriters' Laboratories or Warnock-Hersey.

E. Anchors and Accessories: Manufacturer's standard units. Use galvanized items for units built into exterior walls, complying with ASTM A 153.

2.3 FABRICATION

A. Fabricate units to be rigid, neat in appearance, and free from defects, warp or buckle. Weld exposed joints continuously, grind, dress, and make smooth, flush and invisible.

B. Cut-Outs: Regardless of cut-out locations shown on Drawings, provide flush panel at the bottom 10 inches of each door, in compliance with State of Michigan barrier-free requirements.

C. Prepare steel doors and frames to receive mortised and concealed finish hardware, including cutouts, reinforcing, drilling and tapping, complying with ANSI A 115 "Specifications for Door and Frame Preparation for Hardware".
   1. Prepare frames to receive 3 silencers on strike jambs of single-swing frames and on heads of double-swing frames.
   2. Provide 26-gage steel mortar boxes, welded to frame, at back of hardware cutouts where installed in concrete, masonry or plaster openings.

D. Locate finish hardware per DHI "Recommended Locations for Builder's Hardware".

E. Shop paint exposed surfaces of doors and frame units, including galvanized surfaces, using mfr's standard baked-on rust inhibitive primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Placing Frames: Comply with provisions of SDI 105, unless otherwise indicated. Set frames, with spreaders, accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
   1. Except for frames located in existing concrete, masonry, or gypsum board assembly construction, place frames before constructing enclosing walls and ceilings.
   2. In masonry construction, install at least 3 wall anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
   3. At existing concrete or masonry construction, install at least 3 completed opening anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Set frames and secure to adjacent construction with bolts and masonry anchorage devices.
   4. Install fire-rated frames according to NFPA 80.

B. Door Installation: Fit hollow-metal doors accurately in frames, within clearances specified in ANSI/SDI 100.
   1. Fitting Clearances for Non-Rated Doors: Provide 1/8-inch at jambs and heads; 1/16-inch per leaf at meeting stiles for pairs of doors; and 1/2-inch from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 1/8-inch clearance from bottom of door to top of threshold.
   2. Fire-Rated Doors: Smoke and draft control door assemblies must be tested in accordance with UL 1784. Provide fitting clearances as required to meet the testing requirements of UL 1784 without the use of applied gasketing. Installation and clearances shall be in accordance with NFPA 80.
3.2 ADJUSTING AND CLEANING

A. Prime Coat Touchup: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION 08 11 13
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. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.

1.3 SUBMITTALS
A. Product Data: For each type of door indicated. Include details of core and edge construction, louvers, 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; location and extent of hardware blocking; and other pertinent data.
1. Indicate doors to be factory finished and finish requirements.
2. Indicate fire-protection ratings for fire-rated doors.
C. Samples for Verification: Factory finishes applied to actual door face materials, approximately 8 inches by 10 inches, for each material and finish.
D. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE
A. Source Limitations: Obtain flush wood doors from single manufacturer.
B. Quality Standard: In addition to requirements specified, comply with AWI's “Architectural Woodwork Quality Standards Illustrated” and “Architectural Flush Doors” for grade of door, core construction, and finish.
C. Forest Certification: Provide doors made with cores and veneers not less than 70% 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.”

1.5 DELIVERY, STORAGE, AND HANDLING
A. Comply with requirements of referenced standard and manufacturer's written instructions.
B. Package doors individually in plastic bags or cardboard cartons.

1.6 PROJECT CONDITIONS
A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Algoma Hardwoods, Inc.
   2. Eggers Industries.
   3. Graham; an Assa Abloy Group company.
   5. Oshkosh Architectural Door Company.
   6. VT Industries Inc.

2.2 DOOR CONSTRUCTION, GENERAL

A. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards, WDMA I.S.1-A, "Architectural Wood Flush Doors."
   1. Provide AWI Quality Certification or WI Certified Compliance Labels indicating that doors comply with requirements of grades specified.

B. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.

C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   1. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
   2. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.

D. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.

E. Mineral-Core Doors:
   1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
   2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
   3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

F. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.

2.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:
   1. Grade: Premium, with Grade AA faces.
      a. Veneer Species: White Oak.
      b. Veneer Cut: Rift Cut.
      c. Match between Veneer Leaves: Book Match.
      d. Assembly of Veneer Leaves on Door Faces: Match existing.
   2. Core: Either glued wood stave or structural composite lumber.
   3. Construction: 5 or 7 plies. Stiles and rails are bonded to core, and then entire unit abrasive planed before veneering.
   4. WDMA I.S.1-A Performance Grade: Heavy Duty.
2.4 FABRICATION

A. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.

B. Openings: Cut and trim openings through doors in factory.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Division 08 Section "Glazing."

2.5 FACTORY FINISHING

A. Transparent Finish: Conversion varnish, premium grade system as prescribed by AWI.
   1. Stain: To be selected from manufacturer's standard finishes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames before hanging doors.
   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. Reject doors with defects.

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

3.2 INSTALLATION

A. Hardware: For installation, see Division 08 Section "Door Hardware."

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the 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 edges of doors, edges of cutouts, and mortises 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 unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4-inch from bottom of door to top of threshold unless otherwise indicated.
      a. Comply with NFPA 80 for fire-rated doors.
   2. Bevel fire-rated doors 1/8-inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.
B. Finished Doors: Replace doors that are damaged or 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 08 14 16
SECTION 08 71 11 – DOOR HARDWARE (DESCRIPTIVE SPECIFICATION)

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. Mechanical and electrified door hardware for:
      a. Swinging doors.
   2. Electronic access control system components, including:
      a. Biometric access control reader.
      b. Electronic access control devices.
   3. Field verification, preparation and modification of existing doors and frames to receive new door hardware.
   4. Lead-lining door hardware items required for radiation protection at door openings.

B. Exclusions: Unless specifically listed in hardware sets, hardware is not specified in this section for:
   1. Windows
   2. Cabinets (casework), including locks in cabinets
   3. Signage
   4. Toilet accessories
   5. Overhead doors

1.3 REFERENCES

A. UL - Underwriters Laboratories
   1. UL 10B - Fire Test of Door Assemblies
   2. UL 10C - Positive Pressure Test of Fire Door Assemblies
   3. UL 1784 - Air Leakage Tests of Door Assemblies
   4. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute
   1. Sequence and Format for the Hardware Schedule
   2. Recommended Locations for Builders Hardware
   3. Key Systems and Nomenclature

C. ANSI - American National Standards Institute
   1. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties

1.4 SUBMITTALS

A. General:
   1. Submit in accordance with Conditions of Contract and Division 01 requirements.
   2. Highlight, encircle, or otherwise specifically identify on submittals deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.
   3. Prior to forwarding submittal, comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, “EXAMINATION” article, herein.
B. Action Submittals:

1. **Product Data:** Product data including manufacturers’ technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.

2. **Riser and Wiring Diagrams:** After final approval of hardware schedule, submit details of electrified door hardware, indicating:
   a. **Wiring Diagrams:** For power, signal, and control wiring and including:
      1) Details of interface of electrified door hardware and building safety and security systems.
      2) Schematic diagram of systems that interface with electrified door hardware.
      3) Point-to-point wiring.
      4) Risers.

3. **Samples for Verification:** If requested by Architect, submit production sample or sample installations of each type of exposed hardware unit in finish indicated, and tagged with full description for coordination with schedule.
   a. Samples will be returned to supplier in like-new condition. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.

4. **Door Hardware Schedule:** Submit schedule with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Indicate complete designations of each item required for each door or opening, include:
   a. Door Index; include door number, heading number, and Architects hardware set number.
   b. Opening Lock Function Spreadsheet: List locking device and function for each opening.
   c. Type, style, function, size, and finish of each hardware item.
   d. Name and manufacturer of each item.
   e. Fastenings and other pertinent information.
   f. Location of each hardware set cross-referenced to indications on Drawings.
   g. Explanation of all abbreviations, symbols, and codes contained in schedule.
   h. Mounting locations for hardware.
   i. Door and frame sizes and materials.
   j. Name and phone number for local manufacturer's representative for each product.
   k. Operational Description of openings with any electrified hardware (locks, exits, electromagnetic locks, electric strikes, automatic operators, door position switches, magnetic holders or closer/holder units, and access control components). Operational description should include how door will operate on egress, ingress, and fire and smoke alarm connection.
   1) **Submittal Sequence:** Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work that is critical in Project construction schedule.

5. **Key Schedule:**
   a. After Keying Conference, provide keying schedule listing levels of keying as well as explanation of key system's function, key symbols used and door numbers controlled.
   b. Use ANSI/BHMA A156.28 “Recommended Practices for Keying Systems” as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
   c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
   d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
   e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion.
      1) **Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.**
   f. Prepare key schedule by or under supervision of supplier, detailing Owner’s final keying instructions for locks.

6. **Templates:** After final approval of hardware schedule, provide templates for doors, frames and other work specified to be factory prepared for door hardware installation.
C. Informational Submittals:

1. Qualification Data: For Supplier, Installer and Architectural Hardware Consultant.
2. Product Certificates for electrified door hardware, signed by manufacturer:
   a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
3. Certificates of Compliance:
   a. Certificates of compliance for fire-rated hardware and installation instructions if requested by Architect or Authority Having Jurisdiction.
   b. Installer Training Meeting Certification: Letter of compliance, signed by Contractor, attesting to completion of installer training meeting specified in “QUALITY ASSURANCE” article, herein.
   c. Electrified Hardware Coordination Conference Certification: Letter of compliance, signed by Contractor, attesting to completion of electrified hardware coordination conference, specified in “QUALITY ASSURANCE” article, herein.
4. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by qualified testing agency, for door hardware on doors located in accessible routes.
5. Warranty: Special warranty specified in this Section.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
   a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
   b. Catalog pages for each product.
   c. Name, address, and phone number of local representative for each manufacturer.
   d. Parts list for each product.
   e. Final approved hardware schedule, edited to reflect conditions as-installed.
   f. Final keying schedule
   g. Copies of floor plans with keying nomenclature
   h. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.
   i. Copy of warranties including appropriate reference numbers for manufacturers to identify project.

1.5 QUALITY ASSURANCE

A. Product Substitutions: Comply with product requirements stated in Division 01 and as specified herein.

1. Where specific manufacturer's product is named and accompanied by "No Substitute," including make or model number or other designation, provide product specified. (Note: Certain products have been selected for their unique characteristics and particular project suitability.)
   a. Where no additional products or manufacturers are listed in product category, requirements for “No Substitute” govern product selection.

2. Where products indicate "acceptable manufacturers" or “acceptable manufacturers and products”, provide product from specified manufacturers, subject to compliance with specified requirements and “Single Source Responsibility” requirements stated herein.

B. Supplier Qualifications and Responsibilities: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that provides certified Architectural Hardware Consultant (AHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
4. Coordination Responsibility: Coordinate installation of electronic security hardware with Architect and electrical engineers and provide installation and technical data to Architect and other related subcontractors.
   a. Upon completion of electronic security hardware installation, inspect and verify that all components are working properly.
C. Installer Qualifications: Qualified tradesmen, skilled in application of commercial grade hardware with record of successful in-service performance for installing door hardware similar in quantity, type, and quality to that indicated for this Project.

D. Architectural Hardware Consultant Qualifications: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
   1. For door hardware, DHI-certified, Architectural Hardware Consultant (AHC).
   2. Can provide installation and technical data to Architect and other related subcontractors.
   3. Can inspect and verify components are in working order upon completion of installation.
   5. Capable of coordinating installation of electrified hardware with Architect and electrical engineers.

E. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.
   1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated.
   2. Manufacturers that perform electrical modifications and that are listed by testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

F. Fire-Rated Door Openings: Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.

G. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
   1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.

H. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.

I. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release latch. Locks do not require use of key, tool, or special knowledge for operation.

J. Accessibility Requirements: For door hardware on doors in an accessible route, comply with governing accessibility regulations cited in “REFERENCES” article, herein.
   1. Provide operating devices that do not require tight grasping, pinching, or twisting of wrist and that operate with force of not more than 5 lbf (22.2 N).
   2. Maximum opening-force requirements:
      a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
      b. Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.
      c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
   3. Bevel raised thresholds with slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
   4. Adjust door closer sweep periods so that, from open position of 70 degrees, door will take at least 3 seconds to move to 3 inches (75 mm) from latch, measured to leading edge of door.
K. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01.
   2. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
      a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
      b. Preliminary key system schematic diagram.
      c. Requirements for key control system.
      d. Requirements for access control.
      e. Address for delivery of keys.

L. Pre-installation Conference: Conduct conference at Project site
   1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Inspect and discuss preparatory work performed by other trades.
   3. Inspect and discuss electrical roughing-in for electrified door hardware.
   4. Review sequence of operation for each type of electrified door hardware.
   5. Review required testing, inspecting, and certifying procedures.

M. Coordination Conferences:
   1. Installation Coordination Conference: Prior to hardware installation, schedule and hold meeting to review questions or concerns related to proper installation and adjustment of door hardware.
      a. Attendees: Door hardware supplier, door hardware installer, Contractor.
      b. After meeting, provide letter of compliance to Architect, indicating when meeting was held and who was in attendance.
   2. Electrified Hardware Coordination Conference: Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.
      a. Attendees: electrified door hardware supplier, doors and frames supplier, electrified door hardware installer, electrical subcontractor, Owner, Architect and Contractor.
      b. After meeting, provide letter of compliance to Architect, indicating when coordination conference was held and who was in attendance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
   1. Deliver each article of hardware in manufacturer’s original packaging.

C. Project Conditions:
   1. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
   2. Provide secure lock-up for door hardware delivered to Project, but not yet installed. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.

D. Protection and Damage:
   1. Promptly replace products damaged during shipping.
   2. Handle hardware in manner to avoid damage, marriing, or scratching. Correct, replace or repair products damaged during Work.
   3. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.

E. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

F. Deliver keys to Owner by registered mail or overnight package service.
1.7 COORDINATION

A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Security: Coordinate installation of door hardware, keying, and access control with Owner’s security consultant.

D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

E. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

F. Direct shipments not permitted, unless approved by Contractor.

1.8 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Years from date of Substantial Completion, for durations indicated.

a. Closers:
   1) Mechanical: 10 years
   2) Electrified: 2 years.

b. Automatic Operators: 1 year.

c. Exit Devices:
   1) Mechanical: 3 years.
   2) Electrified: 1 year.

d. Locksets:
   1) Mechanical: 3 years.
   2) Electrified: 1 year.

   e. Continuous Hinges: Lifetime warranty.

   f. Key Blanks: Lifetime

2. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The Owner requires use of certain products for their unique characteristics and particular project suitability to insure continuity of existing and future performance and maintenance standards. After investigating available product offerings Awarding Authority has elected to prepare proprietary specifications. These products are specified with the notation: “No Substitute.”

1. Where “No Substitute” is noted, submittals and substitution requests for other products will not be considered.

B. Approval of manufacturers and/or products other than those listed as “Scheduled Manufacturer” or “Acceptable Manufacturers” in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.
C. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.

D. Hand of Door: Drawings show direction of slide, swing, or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.

E. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.2 MATERIALS

A. Fasteners
   1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
   2. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
   3. Provide concealed fasteners for hardware units exposed when door is closed except when no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless thru-bolts are required to fasten hardware securely. Review door specification and advise Architect if thru-bolts are required.
   4. Install hardware with fasteners provided by hardware manufacturer.

B. Modification and Preparation of Existing Doors: Where existing door hardware is indicated to be removed and reinstalled.
   1. Provide necessary fillers, Dutchmen, reinforcements, and fasteners, compatible with existing materials, as required for mounting new opening hardware and to cover existing door and frame preparations.
   2. Use materials which match materials of adjacent modified areas.
   3. When modifying existing fire-rated openings, provide materials permitted by NFPA 80 as required to maintain fire-rating.

C. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
   1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

D. Cable and Connectors: Hardwired Electronic Access Control Lockset and Exit Device Trim:
   1. Data: 24AWG, 4 conductor shielded, Belden 9843, 9841 or comparable.
   2. DC Power: 18 AWG, 2 conductor, Belden 8760 or comparable.
   3. Provide type of data and DC power cabling required by access control device manufacturer for this installation.
   4. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with sufficient number and wire gauge with standardized Molex plug connectors to accommodate electric function of specified hardware. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified pivot, and electric power transfer for connection to power supplies.

2.3 HINGES

A. Provide five-knuckle, ball bearing hinges.
   1. Manufacturers and Products:
      a. Scheduled Manufacturer and Product: Stanley FBB
      b. Acceptable Manufacturers and Products: Hager BB series, McKinney TA/T4A series,

B. Requirements:
   1. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
      a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
1. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
   a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
   b. Interior: Heavy weight, steel, 5 inches (127 mm) high
2. 2 inches or thicker doors:
   a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
   b. Interior: Heavy weight, steel, 5 inches (127 mm) high
3. 2 inches or thicker doors:
   a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
   b. Interior: Heavy weight, steel, 5 inches (127 mm) high
4. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
5. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
6. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
   a. Steel Hinges: Steel pins
   b. Non-Ferrous Hinges: Stainless steel pins
   c. Out-Swinging Exterior Doors: Non-removable pins
   d. Out-Swinging Interior Lockable Doors: Non-removable pins
   e. Interior Non-lockable Doors: Non-rising pins
7. Width of hinges: 4-1/2 inches (114 mm) at 1-3/4 inch (44 mm) thick doors, and 5 inches (127 mm) at 2 inches (51 mm) or thicker doors. Adjust hinge width as required for door, frame, and wall conditions to allow proper degree of opening.
8. Doors 36 inches (914 mm) wide or less furnish hinges 4-1/2 inches (114 mm) high; doors greater than 36 inches (914 mm) wide furnish hinges 5 inches (127 mm) high, heavy weight or standard weight as specified.
9. Provide hinges with electrified options as scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component.
10. Provide mortar guard for each electrified hinge specified, unless specified in hollow metal frame specification.
11. Provide spring hinges where specified. Provide two spring hinges and one bearing hinge per door leaf for doors 90 inches (2286 mm) or less in height. Provide one additional bearing hinge for each 30 inches (762 mm) of additional door height.

2.4 FLUSH BOLTS

A. Manufacturers:
   1. Scheduled Manufacturer: Ives
   2. Acceptable Manufacturers: Burns, Rockwood

B. Requirements:
   1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.5 COORDINATORS

A. Manufacturers:
   1. Scheduled Manufacturer: Ives
   2. Acceptable Manufacturers: Burns, Rockwood

B. Requirements:
   1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide bar-type coordinating device, surface applied to underside of stop at frame head.
2. Provide filler bar of correct length for unit to span entire width of opening, and appropriate brackets for parallel arm door closers and surface vertical rod exit device strikes. Factory-prep coordinators for vertical rod devices if required.

2.6 MORTISE LOCKS

A. Manufacturers and Products:
   1. Scheduled Manufacturer and Product: Best 45H series

B. Requirements:
   1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1 Operational, Grade 1 Security, and manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to “KEYING” article, herein.
   2. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1 inch (25 mm) throw, constructed of stainless steel.
   3. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
   4. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide a request to exit (RX) switch that is actuated with rotation of inside lever.
   5. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.

2.7 EXIT DEVICES

A. Manufacturers and Products:
   1. Scheduled Manufacturer and Product: Von Duprin 98/35 series
   2. Acceptable Manufacturers and Products: Sargent 80 series

B. Requirements:
   1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1, and UL listed for Panic Exit or Fire Exit Hardware. Cylinders: Refer to “KEYING” article, herein.
   2. Provide touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
   3. Touchpad: Extend minimum of one half of door width. Match exit device finish, stainless steel for US26, US26D, US28, US32, and US32D finishes; and for all other finishes, provide compatible finish to exit device. Provide compression springs in devices, latches, and outside trims or controls; tension springs also acceptable.
   4. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
   5. Provide exit devices with manufacturer’s approved strikes.
   6. Provide exit devices cut to door width and height. Locate exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
   7. Mount mechanism case flush on face of doors, or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
   8. Provide hex key dogging at non-fire-rated exit devices, unless specified less dogging or cylinder dogging.
   9. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion that is removed by use of a keyed cylinder, which is self-locking when re-installed.
   10. Where lever handles are specified as outside trim for exit devices, provide heavy-duty lever trims with forged or cast escutcheon plates. Provide vandal-resistant levers that will travel to 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set.
      a. Lever Style: Match lever style of locksets.
      b. Tactile Warning (Knurling): Where required by authority having jurisdiction. Provide on levers on exterior (secure side) of doors serving rooms considered to be hazardous.
11. Provide UL labeled fire exit hardware for fire rated openings.
12. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
13. Provide electrified options as scheduled.

2.8 ELECTRIC STRIKES

A. Manufacturers and Products:
1. Scheduled Manufacturer and Product: Von Duprin 6000 series
2. Acceptable Manufacturers and Products: Folger Adam 300 series, HES 1006 series

B. Requirements:
1. Provide electric strikes designed for use with type of locks shown at each opening.
2. Provide electric strikes UL Listed as burglary-resistant.
3. Where required, provide electric strikes UL Listed for fire doors and frames.
4. Provide fail-secure type electric strikes, unless specified otherwise.
5. Coordinate voltage and provide transformers and rectifiers for each strike as required.

2.9 POWER SUPPLIES

A. Manufacturers and Products:
1. Scheduled Manufacturer and Product: Schlage or Von Duprin PS900 series
2. Acceptable Manufacturers and Products: Precision ELR series, Sargent 3500 series, Dynalock 5000 series, Folger Adam FABPS series, Securitron BPS series, Security Door Controls 600 series

B. Requirements:
1. Provide power supplies, recommended and approved by manufacturer of electrified locking component, for operation of electrified locks, electrified exit devices, magnetic locks, electric strikes, and other components requiring power supply.
2. Provide appropriate quantity of power supplies necessary for proper operation of electrified locking components as recommended by manufacturer of electrified locking components with consideration for each electrified component using power supply, location of power supply, and approved wiring diagrams. Locate power supplies as directed by Architect.
3. Provide regulated and filtered 24 VDC power supply, and UL class 2 listed.
4. Options:
   a. Provide power supply, where specified, with internal capability of charging sealed backup batteries 24 VDC, in addition to operating DC load.
   b. Provide sealed batteries for battery back-up at each power supply where specified.
   c. Provide keyed power supply cabinet.
5. Provide power supply in an enclosure, complete, and requiring 120VAC to fused input.
6. Provide power supply with emergency release terminals, where specified, that allow release of all devices upon activation of fire alarm system complete with fire alarm input for initiating “no delay” exiting mode.

2.10 CYLINDERS

A. Manufacturers:
1. Scheduled Manufacturer: Best
2. Acceptable Manufacturers: No Substitute

B. Requirements:
1. Provide cylinders/cores, from the same manufacturer of locksets, compliant with ANSI/BHMA A156.5; latest revision, Section 12, Grade 1; permanent cylinders; cylinder face finished to match lockset, manufacturer’s series as indicated. Refer to “KEYING” article, herein.
2. Nickel silver bottom pins.
3. Replaceable Construction Cores.
   a. Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
      1) 12 construction change (day) keys.
   b. Owner or Owner’s Representative will replace temporary construction cores with permanent cores.

2.11 KEYING

A. Key to existing Best key system as directed by Owner. Hold Keying conference with Owner to determine keying requirements.

2.12 DOOR CLOSERS

A. Manufacturers and Products:
   1. Scheduled Manufacturer and Product: LCN 4040XP series
   2. Acceptable Manufacturers and Products: Norton 9500 series, Corbin Russwin DC8000 series

B. Requirements:
   1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. Stamp units with date of manufacture code.
   2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
   3. Cylinder Body: 1-1/2 inch (38 mm) diameter, with 5/8 inch (16 mm) diameter double heat-treated pinion journal.
   4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
   5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
   6. Hydraulic Regulation: By tamper-proof, non-critical valves with separate adjustment for latch speed, general speed, and backcheck.
   7. Provide closers with a solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
   8. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI/BHMA Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
   9. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.13 DOOR TRIM

A. Manufacturers:
   1. Scheduled Manufacturer: Ives
   2. Acceptable Manufacturers: Burns, Rockwood

B. Requirements:
   1. Provide push plates 4 inches (102 mm) wide by 16 inches (406 mm) high by 0.050 inch (1 mm) thick and beveled 4 edges. Where width of door stile prevents use of 4 inches (102 mm) wide plate, adjust width to fit.
   2. Provide push bars of solid bar stock, diameter and length as scheduled. Provide push bars of sufficient length to span from center to center of each stile. Where required, mount back to back with pull.
   3. Provide offset pulls of solid bar stock, diameter and length as scheduled. Where required, mount back to back with push bar.
   4. Provide flush pulls as scheduled. Where required, provide back-to-back mounted model.
   5. Provide pulls of solid bar stock, diameter and length as scheduled. Where required, mount back to back with push bar.
6. Provide pull plates 4 inches (102 mm) wide by 16 inches (406 mm) high by 0.050 inch (1 mm) thick, beveled 4 edges, and prepped for pull. Where width of door stile prevents use of 4 inches (102 mm) wide plate, adjust width to fit.
7. Provide wire pulls of solid bar stock, diameter and length as scheduled.
8. Provide decorative pulls as scheduled. Where required, mount back to back with pull.

2.14 PROTECTION PLATES

A. Manufacturers:
   1. Scheduled Manufacturer: Ives
   2. Acceptable Manufacturers: Burns, Rockwood

B. Requirements:
   1. Provide kick plates, mop plates, and armor plates minimum of 0.050 inch (1 mm) thick as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
   2. Sizes of plates:
      a. Kick Plates: 10 inches (254 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs
      b. Mop Plates: 4 inches (102 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs
      c. Armor Plates: 36 inches (914 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs

2.15 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:
   1. Scheduled Manufacturers: Glynn-Johnson
   2. Acceptable Manufacturers: Rixson, Sargent

B. Requirements:
   1. Provide heavy duty concealed mounted overhead stop or holder as specified for exterior and interior vestibule single acting doors.
   2. Provide heavy duty concealed mounted overhead stop or holder as specified for double acting doors.
   3. Provide heavy or medium duty and concealed or surface mounted overhead stop or holder for interior doors as specified. Provide medium duty surface mounted overhead stop for interior doors and at any door that swings more than 140 degrees before striking wall, open against equipment, casework, sidelights, and where conditions do not allow wall stop or floor stop presents tripping hazard.
   4. Where overhead holders are specified provide friction type at doors without closer and positive type at doors with closer.

2.16 DOOR STOPS AND HOLDERS

A. Manufacturers:
   1. Scheduled Manufacturer: Ives
   2. Acceptable Manufacturers: Burns, Rockwood

B. Provide door stops at each door leaf:
   1. Provide wall stops wherever possible. Provide convex type where mortise type locks are used and concave type where cylindrical type locks are used.
   2. Where a wall stop cannot be used, provide universal floor stops for low or high rise options.
   3. Where wall or floor stop cannot be used, provide medium duty surface mounted overhead stop.

2.17 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:
   1. Scheduled Manufacturer: Zero
   2. Acceptable Manufacturers: National Guard, Reese
B. Requirements:
1. Provide thresholds, weatherstripping (including door sweeps, seals, astragals) and gasketing systems (including smoke, sound, and light) as specified and per architectural details. Match finish of other items.
2. Size of thresholds:
   a. Saddle Thresholds: 1/2 inch (13 mm) high by jamb width by door width
   b. Bumper Seal Thresholds: 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width
3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.

2.18 SILENCERS

A. Manufacturers:
   1. Scheduled Manufacturer: Ives
   2. Acceptable Manufacturers: Burns, Rockwood

B. Requirements:
   1. Provide "push-in" type silencers for hollow metal or wood frames.
   2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
   3. Omit where gasketing is specified.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Existing Door and Frame Compatibility: Field verify existing doors and frames receiving new hardware and existing conditions receiving new openings. Verify that new hardware is compatible with existing door and frame preparation and existing conditions.

C. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

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

3.2 PREPARATION

A. Where on-site modification of doors and frames is required:
   1. Carefully remove existing door hardware and components being reused. Clean, protect, tag, and store in accordance with storage and handling requirements specified herein.
   2. Field modify and prepare existing door and frame for new hardware being installed.
   3. When modifications are exposed to view, use concealed fasteners, when possible.
   4. Prepare hardware locations and reinstall in accordance with installation requirements for new door hardware and with:
      a. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
      b. Wood Doors: DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."
      c. Doors in rated assemblies: NFPA 80 for restrictions on on-site door hardware preparation.
3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
   2. Custom Steel Doors and Frames: HMMA 831.

B. Install each hardware item in compliance with manufacturer’s instructions and recommendations, using only fasteners provided by manufacturer.

C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.

D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.

E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.

G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

H. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches (750 mm) of door height greater than 90 inches (2286 mm).

I. Lock Cylinders: Install construction cores to secure building and areas during construction period.
   1. Replace construction cores with permanent cores as indicated in keying section.

J. Lead Protection: Lead wrap hardware penetrating lead-lined doors. Levers and roses to be lead lined. Apply kick and armor plates on lead-lined doors with adhesive as recommended by manufacturer.

K. Wiring: Coordinate with Division 26, ELECTRICAL sections for:
   1. Conduit, junction boxes and wire pulls.
   2. Connections to and from power supplies to electrified hardware.
   3. Connections to fire/smoke alarm system and smoke evacuation system.
   4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
   5. Testing and labeling wires with Architect’s opening number.

L. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

M. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Closers shall not be visible in corridors, lobbies and other public spaces unless approved by Architect.

N. Closer/Holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
O. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.
   1. Configuration: Provide least number of power supplies required to adequately serve doors with electrified door hardware.

P. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

Q. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.

R. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

S. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

T. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

A. Architectural Hardware Consultant: Engage qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
   1. Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed 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.
   1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
   2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
   3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

A. Provide training for Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."
### 3.8 Door Hardware Schedule

**A.** Locksets, exit devices, and other hardware items are referenced in the following hardware sets for series, type and function. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.

**B.** Hardware Sets:

#### Hardware Group No. 01

For use on mark/door #s: 216

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
<th>Catalog Number</th>
<th>Finish</th>
<th>Mfr</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HINGE</td>
<td>FBB179 4.5&quot; X 4.5&quot;</td>
<td>652</td>
<td>STA</td>
</tr>
<tr>
<td>1</td>
<td>PASSAGE SET</td>
<td>45H0N 14H</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>WALL STOP</td>
<td>WS406/407CVX</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>3</td>
<td>SILENCER</td>
<td>SR64</td>
<td>GRY</td>
<td>IVE</td>
</tr>
</tbody>
</table>

#### Hardware Group No. 02

For use on mark/door #s: 119 203

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
<th>Catalog Number</th>
<th>Finish</th>
<th>Mfr</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HINGE</td>
<td>FBB168 4.5&quot; X 4.5&quot;</td>
<td>652</td>
<td>STA</td>
</tr>
<tr>
<td>1</td>
<td>PRIVACY LOCK W/ OCC IND</td>
<td>45H0L 14H</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>SURFACE CLOSER</td>
<td>4011</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>KICK PLATE</td>
<td>8400 10&quot; X 1 1/2&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>WALL STOP</td>
<td>WS406/407CVX</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>GASKETING</td>
<td>488SBK PSA</td>
<td>BK</td>
<td>ZER</td>
</tr>
</tbody>
</table>
Hardware Group No. 03

For use on mark/door # (s):

251B

Each To Have:

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
<th>Catalog Number</th>
<th>Finish</th>
<th>Mfr</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>HINGE</td>
<td>FBB179 4.5&quot; X 4.5&quot;</td>
<td>652</td>
<td>STA</td>
</tr>
<tr>
<td>1</td>
<td>AUTO FLUSH BOLT</td>
<td>FB31P/FB41P (AS REQ'D)</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>DUST PROOF STRIKE</td>
<td>DP2</td>
<td>626</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>STOREROOM LOCK</td>
<td>45H7D 14H</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>PERMANENT CORE</td>
<td>1C7*2</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td></td>
<td>- VERIFY CORE AND KEYWAY PRIOR TO ORDERING</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>COORDINATOR</td>
<td>COR X FL (MB AS REQ'D)</td>
<td>628</td>
<td>IVE</td>
</tr>
<tr>
<td>2</td>
<td>SURFACE CLOSER</td>
<td>4040XP</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>2</td>
<td>KICK PLATE</td>
<td>8400 10&quot; X 1&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>2</td>
<td>WALL STOP</td>
<td>WS33/WS33X</td>
<td>626</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>GASKETING</td>
<td>488SBK PSA</td>
<td>BK</td>
<td>ZER</td>
</tr>
<tr>
<td>1</td>
<td>WEATHERSTRIPPING</td>
<td>8217SBK PSA</td>
<td>BK</td>
<td>ZER</td>
</tr>
</tbody>
</table>
## Door Hardware (Descriptive Specification)

**Wayne State University**  
University Services Building – HVAC and Fire Alarm  
WSU Project Number 060-313984  
FTCH Project Number 180756

### Hardware Group No. 04

For use on mark/door #s:  
202 209

Each To Have:

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
<th>Catalog Number</th>
<th>Finish</th>
<th>Mfr</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HINGE</td>
<td>FBB179 4.5&quot; X 4.5&quot;</td>
<td>652</td>
<td>STA</td>
</tr>
<tr>
<td>1</td>
<td>OFFICE/ENTRY LOCK</td>
<td>45H7A 14H</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>PERMANENT CORE</td>
<td>1C7*2</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- VERIFY CORE AND KEYWAY PRIOR TO ORDERING</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>WALL STOP</td>
<td>WS406/407CVX</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>3</td>
<td>SILENCER</td>
<td>SR64</td>
<td>GRY</td>
<td>IVE</td>
</tr>
</tbody>
</table>

### Hardware Group No. 05

For use on mark/door #s:  
235 236.2B

Each To Have:

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
<th>Catalog Number</th>
<th>Finish</th>
<th>Mfr</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HINGE</td>
<td>FBB168 4.5&quot; X 4.5&quot;</td>
<td>652</td>
<td>STA</td>
</tr>
<tr>
<td>1</td>
<td>OFFICE/ENTRY LOCK</td>
<td>45H7A 14H</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>PERMANENT CORE</td>
<td>1C7*2</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- VERIFY CORE AND KEYWAY PRIOR TO ORDERING</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>SURFACE CLOSER</td>
<td>4040XP</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>KICK PLATE</td>
<td>8400 10&quot; X 1 1/2&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>WALL STOP</td>
<td>WS406/407CVX</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>GASKETING</td>
<td>488SBK PSA</td>
<td>BK</td>
<td>ZER</td>
</tr>
</tbody>
</table>
Hardware Group No. 06

For use on mark/door #211:

Each To Have:

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
<th>Catalog Number</th>
<th>Finish</th>
<th>Mfr</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HINGE</td>
<td>FBB179 4.5&quot; X 4.5&quot;</td>
<td>652</td>
<td>STA</td>
</tr>
<tr>
<td>1</td>
<td>STOREROOM LOCK</td>
<td>45H7D 14H</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>PERMANENT CORE</td>
<td>1C7*2</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>WALL STOP</td>
<td>WS406/407CVX</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>3</td>
<td>SILENCER</td>
<td>SR64</td>
<td>GRY</td>
<td>IVE</td>
</tr>
</tbody>
</table>

Hardware Group No. 07

For use on mark/door #2C1C:

Each To Have:

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
<th>Catalog Number</th>
<th>Finish</th>
<th>Mfr</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>HINGE</td>
<td>FBB168 5&quot; X 4.5&quot;</td>
<td>652</td>
<td>STA</td>
</tr>
<tr>
<td>1</td>
<td>FIRE EXIT HARDWARE</td>
<td>98-L-F-17</td>
<td>626</td>
<td>VON</td>
</tr>
<tr>
<td>1</td>
<td>RIM CYLINDER (SFIC)</td>
<td>1E72</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td>1</td>
<td>PERMANENT CORE</td>
<td>1C7*2</td>
<td>626</td>
<td>BES</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>SURFACE CLOSER</td>
<td>4040XP EDA</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>KICK PLATE</td>
<td>8400 10&quot; X 1 1/2&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>FIRE/LIFE WALL MAG</td>
<td>SEM7850</td>
<td>689</td>
<td>LCN</td>
</tr>
<tr>
<td>1</td>
<td>GASKETING</td>
<td>488SBK PSA</td>
<td>BK</td>
<td>ZER</td>
</tr>
</tbody>
</table>
Hardware Group No. 08

For use on mark/door #(#(s):

206

Each To Have:

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
<th>Catalog Number</th>
<th>Finish</th>
<th>Mfr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 EA</td>
<td>ELECTRIC STRIKE</td>
<td>6300 FSE</td>
<td>630 VON</td>
<td></td>
</tr>
<tr>
<td>1 EA</td>
<td>CREDENTIAL READER</td>
<td>MERCURY BR20</td>
<td></td>
<td>MER</td>
</tr>
<tr>
<td>1 EA</td>
<td>POWER SUPPLY</td>
<td>PS902 BBK 900-2RS</td>
<td>LGR SCE</td>
<td></td>
</tr>
</tbody>
</table>

- BALANCE OF HARDWARE EXISTING

DOOR NORMALLY LOCKED. ACCESS BY CARD READER.

VERIFY EXISTING HARDWARE IN FIELD FOR FUNCTIONALITY.

TIE CREDENTIAL READER AND ELECTRIC STRIKE INTO EXISTING ACCESS CONTROL SYSTEM. COORDINATE WITH ELECTRICAL, ACCESS CONTROL AND ALL RELATED TRADES.

Hardware Group No. 09

For use on mark/door #(#(s):

204

Each To Have:

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
<th>Catalog Number</th>
<th>Finish</th>
<th>Mfr</th>
</tr>
</thead>
</table>

EXISTING DOOR, FRAME AND HARDWARE TO REMAIN

END OF SECTION 08 71 11
SECTION 09 22 16 – NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes non-load-bearing steel framing systems for interior gypsum board assemblies.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Fire-Test-Response Characteristics: Provide materials and construction identical to those tested according to ASTM E 119.
B. 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.

2.2 FRAMING SYSTEMS
A. Steel Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners of equivalent minimum base-metal thickness.
   1. Manufacturers: Subject to compliance with requirements, provide one of the following:
      1) Clark Dietrich Metal Framing.
      2) MBA Building Supplies.
      3) MRI Steel Framing, LLC.
      4) Steel Network Inc.
      5) Superior Metal Trim.
      6) Telling Industries.
      9. Depth: As indicated on Drawings.

B. Slip-Type Head Joints: Provide one of the following in thickness not less than indicated for studs and in width to accommodate depth of studs:
   1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch deep flanges, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
   2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch deep flanges and fastened to studs, and outer runner sized to friction fit inside runner.
   3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes due to deflection of structure above.
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) Clark Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
         2) MBA Building Supplies; Slotted Deflecto Track.
         3) Steel Network Inc. (The); VertiTrack VT Series.
         4) Superior Metal Trim; Superior Flex Track System (SFT).
         5) Telling Industries; Vertical Slip Track II.
C. Firestop Tracks: 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.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fire Trak Corp.; Fire Trak System.
      c. Metal-Lite, Inc.; The System.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Manufacturers: Subject to compliance with requirements, provide one of the following:
      a. MRI Steel Framing, LLC.
   2. Minimum Base-Metal Thickness: As indicated on Drawings.

E. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch wide flanges.
   1. Manufacturers: Subject to compliance with requirements, provide one of the following:
      a. MRI Steel Framing, LLC.
   2. Depth: 1-1/2 inches.
   3. Clip Angle: Not less than 1-1/2 inches by 1-1/2 inches, 0.068-inch thick, galvanized steel.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   1. Manufacturers: Subject to compliance with requirements, provide one of the following:
      a. MRI Steel Framing, LLC.
   2. Minimum Base-Metal Thickness: 0.018-inch.

G. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch wide flanges.
   1. Depth: 3/4-inch.
   2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033-inch.
   3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch diameter wire, or double strand of 0.048-inch diameter wire.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch diameter wire, or double strand of 0.048-inch diameter wire.

B. Hanger Attachments to Concrete:
   1. Anchors: Capable of sustaining a load equal to 5 times that imposed as determined by ASTM E 488.
      a. Type: Postinstalled, expansion anchor.
   2. Powder-Actuated Fasteners: Capable of sustaining, a load equal to 10 times that imposed as determined by ASTM E 1190.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Flat Hangers: Steel sheet, 1-inch by 3/16-inch by length indicated.

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053-inch and minimum 1/2-inch wide flanges.
   1. Depth: 2-1/2 inches.

F. Furring Channels (Furring Members):
   1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch wide flanges, 3/4-inch deep.
   2. Steel Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners of equivalent minimum base-metal thickness.
   3. Minimum Base-Metal Thickness: TBD.
   4. Depth: TBD.
Non-Structural Metal Framing

Section 09 22 16

   1. Minimum Base-Metal Thickness: 0.018-inch.

2.4 AUXILIARY MATERIALS

A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide asphalt saturated organic felt or foam gasket.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.
   1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 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.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.2 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Install studs so flanges within framing system point in same direction.

C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
   1. 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.
   2. 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.
      a. Install two studs at each jamb unless otherwise indicated.
      b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
      c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
   3. 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.
      a. 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.
         1) Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
      4. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

D. Direct Furring: Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3.3 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. 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.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
   3. Do not attach hangers to steel roof deck.
   4. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   5. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   6. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Installation Tolerances: Install suspension systems that are level to within 1/8-inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 22 16
SECTION 09 29 00 – GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes interior gypsum board.

B. Related Requirements: Division 07 Section “Expansion Joint Systems.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency or as specified in accordance with UL in its “Fire Resistance Directory”.

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.

2.2 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Gypsum.
   2. CertainTeed Corporation.
   3. Georgia-Pacific Building Products.
   4. Lafarge North America Inc.
   6. PABCO Gypsum.
   8. USG Corporation.

B. Gypsum Wallboard: ASTM C 1396/C 1396M.
   1. Thickness: 5/8 inch.
   2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

C. Gypsum Board, Type X: ASTM C 1396/C 1396M.
   1. Thickness: 5/8 inch.
   2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

D. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
   1. Thickness: 5/8 inch.
   2. Long Edges: Tapered.

2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.
   1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
B. Expansion Joint Covers: See Division 07 Section “Expansion Joint Systems,” for assembly to use to span existing building expansion joints in new walls.
1. Size cover as required for width of joint.
2. Provide fire rated cover as appropriate for wall type.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:
1. Interior Gypsum Board: Paper.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

2.5 AUXILIARY MATERIALS

A. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

B. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing).

C. Acoustical Joint Sealant: ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
   b. Grabber Construction Products; Acoustical Sealant GSC.
   c. Pecora Corporation; AC-20 FTR.
   e. USG Corporation; SHEETROCK Acoustical Sealant.

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS

A. Comply with ASTM C 840.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

D. Install trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
1. Aluminum Trim: Install in locations as indicated on Drawings.
2. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C 840.

E. Install expansion joint cover of width required for existing joint. Install following manufacturers recommended procedures.

F. Prefill open joints, rounded or beveled edges, and damaged surface areas.

G. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
H. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
   1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
   2. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

I. 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.

J. Remove and replace panels that are wet, moisture damaged, and/or mold damaged.

END OF SECTION 09 29 00
Tiling

SECTION 09 30 00 - TILING

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. Porcelain floor tile and base.
   2. Ceramic wall tile.
   3. Crack isolation membrane.
   4. Metal edge strips.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.


1.4 PERFORMANCE REQUIREMENTS

A. Dynamic Coefficient of Friction (DCOF): For tile installed on walkway surfaces, provide products with the following DCOF AcuTest values in accordance with ANSI A137.1:
   1. Level Surfaces: Minimum 0.42.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Verification:
   1. Full-size units of each type and composition of tile and for each color and finish required.
   2. Metal edge strips in 3-inch lengths.

C. Qualification Data: For qualified Installer.

D. Product Certificates: For each type of product, signed by product manufacturer.

E. Material Test Reports: For each tile-setting and -grouting product, and special purpose tile.

F. Manufacturer’s System Warranty: Obtain 25 year system limited warranty from Laticrete; warranty is contingent on installation of the specified Laticrete products included in this Specification.

1.6 QUALITY ASSURANCE

A. Source Limitations for Tile Finish Systems: Obtain tile and all other materials for specific tile systems from one source
   1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
2. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.

3. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:
   a. Waterproof membrane.
   b. Crack isolation membrane.
   c. Joint sealants.
   d. Metal edge strips.

1.7 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.

1.8 PROJECT CONDITIONS

A. 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.

1.9 EXTRA MATERIALS

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 5% of amount installed for each type, composition, color, pattern, and size indicated; min. 3 sf of tile.
   2. Grout: Furnish quantity of grout equal to 5% of amount installed for each type, composition, and color indicated.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
   1. Provide tile complying with Standard grade requirements unless otherwise indicated.

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. 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.
   1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

D. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.2 TILE PRODUCTS

A. Tile Types: As indicated on the Drawings.

2.3 WATERPROOF AND CRACK ISOLATION MEMBRANE

A. Waterproofing/crack isolation single component self curing liquid rubber polymer.
   1. Products: Subject to compliance with requirements in ANSI A118.10 and A118.12, provide the following:
      b. No substitutions.

2.4 SETTING MATERIALS

A. Thin Set Polymer Fortified Mortar: Comply with requirements in ANSI A118.4 and A118.11.
   1. For wall applications, provide mortar that complies with requirements for non-sagging mortar in ASNI 118.4.
   2. Manufacturers: Subject to compliance with requirements, provide the following:
      a. Custom Building Products Prolite Premium Large Format Tile Mortar.

B. Organic Adhesive: ANSI A136.1, Type I, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Custom Building Products Reliabond Professional Tile Adhesive.

2.5 GROUT MATERIALS

A. Epoxy-Based Stainproof Tile Grout: ANSI A118.3.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by the following:
      a. Custom Building Products CEG-Lite 100% Solids Commercial Epoxy Grout.

2.6 ELASTOMERIC SEALANTS

A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements.
   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.

B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.
C. One-Part, Mildew-Resistant Silicone Sealant: 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 ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Custom Building Products Commercial 100% Silicone Caulk.

2.7 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
   1. Products: Subject to compliance with requirements, provide products by the following:
      a. Custom Building Products.

B. Metal Trim Profiles:
   1. Floors: As indicated on Drawings.
   2. Walls: As indicated on Drawings.

C. Temporary Protective Coating: Product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.
   1. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.

D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

E. Grout Sealer: Manufacturer’s standard silicone product for sealing grout joints and that does not change color or appearance of grout.
   1. Products: Subject to compliance with requirements, provide products by the following:
      a. Custom Building Products.

2.8 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, and 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 installed with adhesives, bonded mortar bed or thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
   a. Verify that entire tile area surfaces that received a steel trowel finish have been mechanically scarified.
   b. Verify that protrusions, bumps, and ridges have been removed and that surfaces are smooth.
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. In locations where control joints are to be provided but are not specifically located, Contractor shall submit drawings proposed locations to Architect for review and approval. Architect shall have the option to adjust control joint locations and relocate or add control joints.

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

3.2 PREPARATION
A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with adhesives or thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
B. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.
C. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 TILE INSTALLATION
A. Install tile according to TCNA F125A, full detail; with thin set bed.
B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
D. Jointing Pattern: Lay out tile on grid pattern. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
   1. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
   2. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
   3. Floor tile layout to be preapproved by Architect.
E. Joint Widths: As indicated on Finish Legend.
F. Metal Trims Edge Strips: Install at locations indicated and where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile. Refer to Finish Legend.

H. Grout Sealer: Apply grout sealer according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 WATERPROOF AND CRACK ISOLATION MEMBRANE INSTALLATION

A. Install full area substrate coverage waterproof and crack isolation membrane to comply with ANSI A118.10 and A118.12 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.

B. Do not install tile or setting materials over waterproof and crack isolation membrane until membrane has cured.

C. Waterproof and crack isolation membrane to be located at all floor tile areas.

D. Extend waterproof and crack isolation membrane a minimum of 6 inches up walls in wet areas.

3.5 CLEANING AND PROTECTING

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
   1. Remove latex-portland cement grout residue from tile as soon as possible.
   2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
   3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.

B. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed. Where more than seven days or more details traffic protection is recommended from tile manufacturer, follow manufacturer's recommendations.

D. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

END OF SECTION 09 30 00
SECTION 09 51 00 - ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Extent of acoustical ceilings is indicated on Drawings and schedules.

B. Types of acoustical ceiling products include the following:
   1. Acoustical lay-in panels of the following types:
      a. Standard acoustic panels.
   2. Suspended grid systems, specialty trim and accessories.

1.3 RELATED SECTIONS

A. Refer to Division 02 Section "Selective Demolition" for requirements for recycling demolished acoustical ceiling products.

B. Cleanroom acoustic ceilings are specified in Division 13 Section “Cleanrooms.”

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's literature, including certification by a recognized independent testing laboratory, indicating compliance with requirements.

B. Affidavits of Compliance to be included in final inspection manual:
   1. Provide manufacturer's letter of certification showing compliance with finish testing and classification requirements referenced by current adopted NFPA 101 "Life Safety Code".
   2. Letter shall include project number, project name, and building name.

1.5 QUALITY ASSURANCE

A. Standards: Comply with the following:
   3. Surface Burning Characteristics: Flame spread: 25 or less; smoke developed: 50 or less; per ASTM E 84. UL listed and marked.

B. Source Limitations: Obtain each type of acoustic panel and related grid system from one source and by a single manufacturer.

1.6 PROJECT CONDITIONS

A. Do not install ceilings until ambient temperature and humidity conditions can be continuously maintained at values near those intended for final occupancy.

B. Building areas to receive ceiling shall be free of construction dust and debris.
PART 2 - PRODUCTS

2.1 STANDARD ACOUSTIC PANELS

A. Smooth surface, humidity-tolerant, mineral composition panels with washable surface; and as follows:
   1. Surface: Perforated.
   2. Edges: Square.
   3. Size: 24 inches by 24 inches by 5/8 inch thick to match existing – or as indicated on the Drawings.
   4. LR: Not less than 0.82.
   5. NRC: Not less than 0.55.
   6. CAC: Not less than 33.
   8. Manufacturer/Style: Provide one of the following:
      b. "Fine Fissured"; CertainTeed Saint-Gobain.
      c. "Radar ClimaPlus"; U.S. Gypsum. (basis of design)
   9. Related Suspension Grid: Standard 15/16-inch Panel Suspension System in compliance with requirements of "Suspension Systems" Article of this Section.

2.2 SUSPENSION SYSTEMS

A. Suspension Systems, General: As required to support acoustical units, electrical and mechanical fixtures and other components as indicated, including anchorages, hangers, runners, cross runners, splines, clips, moldings, fasteners and other members, devices and accessories. Comply with requirements of ASTM C 635.
   1. Hanger Wire: Not less than 12 gage (0.106 inch) galvanized steel.
   2. Type: Exposed Direct-Hung Steel Suspension System

B. Standard 15/16-inch Panel Suspension System: Suspension system with exposed faces painted.
   1. Face Width: 15/16-inch wide.
   2. Product/Manufacturer: Provide the following:
      c. "Donn DX"; U.S. Gypsum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with ASTM C636 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Layout: Balance ceiling borders on opposite sides, using more-than-half width acoustical units, except where otherwise dimensioned or indicated.
   1. Tolerance: 1/8 inch in 12 feet level tolerance.

C. Suspension System: Secure to building structure, free from contact with objects within the ceiling plenum, with hangers spaced 48 inches on center along supported members; provide hangers not more than 8 inches from ends of each member.
   1. Where interference with ducts or suspended equipment prevents direct connection of suspension elements to building structure, provide steel channel members (Unistrut or equivalent) hung from structural members with threaded rods with appropriate fasteners; and adequately sized for suspension system capacity. Secure suspension system to steel channels. Connection to ductwork or equipment is not permitted.
   2. Do not fasten ceiling suspension members to metal roof deck.
D. Edge Moldings: Secure to substrate with screw anchors spaced 16 inch on center. Set with concealed bead of acoustical sealant. Miter corner joints. Cope exposed flanges of intersecting suspension members for flush intersections.

3.2 CLEANING AND REPAIR

A. Clean suspension grid and panels. Remove and replace panels and grid that are defective, or that have been damaged.

B. Touch-up paint field-cut edges of factory painted tile that are exposed to view in finished installation, including horizontal and vertical surfaces at perimeter of ceilings where panels are cut for rabbeted edge molding.

END OF SECTION 09 51 00
SECTION 09 65 13 – RESILIENT BASE AND 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. Resilient base.
   2. Resilient molding accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.

1.4 EXTRA MATERIALS

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. Furnish quantity of full-size units equal to 5% of amount installed for each type, color, and size indicated.

PART 2 - PRODUCTS

2.1 THERMOSET-RUBBER BASE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Roppe Corporation, USA.
   2. Flexco.
   3. Burke Mercer Flooring Products, Division of Burke Industries Inc.

B. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
   1. Style and Location:
      a. Style A, Straight: Provide in areas with carpet.
      b. Style B, Cove: Provide in areas with resilient flooring.

C. Thickness: 0.125 inch.

D. Height: 4 inches.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Job formed or preformed.

G. Inside Corners: Job formed or preformed.

H. Colors: As indicated by manufacturer's designations. Refer to Drawings.
2.2 RUBBER MOLDING ACCESSORY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Roppe Corporation, USA.
   2. Flexco.
   3. VPI, LLC, Floor Products Division.

B. Description: Rubber reducer strip for resilient flooring and transition strips.

C. Profile and Dimensions: As indicated.

D. Locations: Provide rubber molding accessories in areas indicated.

E. Colors and Patterns: As indicated by manufacturer's designations.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until they are the same temperature as the space where they are to be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.
H. Job-Formed Corners:
   1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
   2. Form without producing discoloration (whitening) at bends.

I. Inside Corners:
   1. Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
   2. Miter or cope corners to minimize open joints.

3.3 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer’s written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer’s written instructions for cleaning and protecting resilient products.

B. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 09 65 13
SECTION 09 65 19 – RESILIENT TILE FLOORING

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: Vinyl composition floor tile.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: Full-size units of each color and pattern of floor tile required.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 EXTRA MATERIALS

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 Units: Furnish quantity of full-size units equal to 5% of amount installed for each type, color, and size indicated; min. 3 sf of tile.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient tile flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

   1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 VINYL COMPOSITION FLOOR TILE

A. Products: Subject to compliance with requirements, provide one of the following:

   1. Armstrong World Industries, Inc.
   2. AB; American Biltrite.
   3. Congoleum Corporation.
   4. Mannington Mills, Inc.

B. Tile Standard: ASTM F 1066, Class 2, through-pattern.

C. Wearing Surface: Smooth.

D. Thickness: 0.125 inch.

E. Size: 12 by 12 inches.

F. Colors and Patterns: As indicated by manufacturer's designations. Refer to Drawings.
2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

C. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to floor tile manufacturer’s written instructions to ensure adhesion of resilient products.

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 adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
   3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
   4. Moisture Testing: Proceed with installation only after substrates pass testing according to floor tile manufacturer’s written recommendations, but not less stringent than the following:
      a. Perform anhydrous calcium chloride test according to 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.
      b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level.

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.

D. Do not install floor tiles until they are the same temperature as the space where they are to be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.2 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.
   1. Lay tiles square with room axis and in pattern indicated.

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.
   1. Lay tiles with grain direction alternating in adjacent tiles (basket-weave pattern) and in pattern of colors and sizes indicated.

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.

3.3 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.

B. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
   1. Apply 3 coats.

C. Cover floor tile until Substantial Completion.

END OF SECTION 09 65 19
SECTION 09 68 13 - TILE CARPETING

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 modular, tufted carpet tile.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: Show the following:
   1. Pattern type, location, and direction.
   2. Type, color, and location of insets and borders.
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. Modular carpet tiles.
   2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch long Samples.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer.

1.5 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. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Comply with CRI 104.

1.8 FIELD CONDITIONS
A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.
B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slab's pH range recommended by carpet tile manufacturer.
1.9 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
   1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
   2. Failures include, but are not limited to, more than 10 percent edge raveling, snags, runs, dimensional stability, excess static discharge, loss of tuft bind strength, loss of face fiber, and delamination.
   3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE – Refer to Finish Legend

A. Products: Subject to compliance with requirements, provide the following:
   1. Refer to Finish Legend.

B. Color: Refer to Finish Legend.

C. Pattern: Refer to Finish Legend.

D. Installation Direction and Type: Refer to Finish Legend.

E. Primary Backing: Manufacturer’s standard backing.

F. Size: Refer to Finish Legend.

G. Performance Characteristics:
   1. Emissions: Provide carpet tile that complies with testing and product requirements of CRI's "Green Label Plus" program.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
   1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Metal Edge/Transition Strips: Extruded aluminum with finish of profile and width shown on the Finish Legend, 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 tile performance. Examine carpet tile for type, color, pattern, and potential defects.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
Tile Carpeting

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

3.2 PREPARATION

A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.

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. 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 carpet tile manufacturer.

D. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.

E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Maintain dye lot integrity. Do not mix dye lots in same area.

D. Cut and fit carpet tile 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 tile manufacturer.

E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

G. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:
   1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
   2. Remove yarns that protrude from carpet tile surface.

B. Protect installed carpet tile to comply with CRI 104, Section 16, "Protecting Indoor Installations."
C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13
SECTION 09 91 00 - PAINTING

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 surface preparation and the application of paint systems on the following substrates:
     1. Exposed interior items and surfaces.
     2. Exposed exterior items and surfaces.
     3. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

  B. All paints and coatings used on the interior of the building (defined as inside of the weatherproofing system and applied on-site), including sealants and adhesives used in mechanical, electrical, and plumbing work, shall comply with the following criteria:

1.3 SUBMITTALS

  A. Product Data: For each type of product indicated.

  B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
     1. Submit Samples on rigid backing, 8 inches square.
     2. Step coats on Samples to show each coat required for system.
     3. Label each coat of each Sample.
     4. Label each Sample for location and application area.
     5. Submit VOC levels of each paint type.

1.4 QUALITY ASSURANCE

  A. MPI Standards:
     1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."

1.5 DELIVERY, STORAGE, AND HANDLING

  A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
     1. Maintain containers in clean condition, free of foreign materials and residue.
     2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

  A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the
dew point; or to damp or wet surfaces.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied
and that are packaged for storage and identified with labels describing contents.
1. Quantity: Furnish an additional 5 percent, but not less than 1 gallon of each material and color
applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide no-VOC products by The Sherwin-
Williams Company or comparable products by one of the following:
1. Benjamin Moore & Co.
2. International Protective Coatings.
3. O'Leary Paint Co.
4. PPG Industries, Inc.
5. Pratt & Lambert Paints.
7. Tnemec.

2.2 PAINT, GENERAL

A. Material Compatibility:
1. Provide materials for use within each paint system that are compatible with one another and
substrates indicated, under conditions of service and application as demonstrated by manufacturer,
based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of
topcoat for use in paint system and on substrate indicated.

B. VOC Content for Interior Paints: For interior paints and 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. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antitrust Paints Applied to Ferrous Metals: 250 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Floor Coatings: 100 g/L.
9. Shellacs, Clear: 730 g/L.
10. Shellacs, Pigmented: 550 g/L.

C. Colors: As selected by the Owner.

2.3 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer: MPI #50.

2.4 LATEX PAINTS AT GYPSUM BOARD

A. Interior Latex (Flat): MPI #53 (Gloss Level 1).
B. Interior Latex (Eggshell): MPI #52 (Gloss Level 3).
C. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).
2.5  ACRYLIC PAINTS AT STEEL

A.  Steel Substrates:
   1.  1 Coat Pro Industrial Pro-Cryl Universal Water Based Primer.
   2.  2 Coats Pro Industrial Zero VOC Acrylic.

PART 3 - EXECUTION

3.1  EXAMINATION

A.  Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B.  Maximum Moisture Content of Substrates:  When measured with an electronic moisture meter as follows:
   1.  Gypsum Board:  12 percent.

C.  Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D.  Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.  Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2  PREPARATION

A.  Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B.  Remove plates, machined surfaces, and similar items already in place that are not to be painted.  If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1.  After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed.  Remove surface-applied protection if any.
   2.  Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C.  Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.  Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

D.  Steel Substrates:  Remove rust and loose mill scale.  Clean using methods recommended in writing by paint manufacturer.

E.  Shop-Primed Steel Substrates:  Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

F.  Gypsum Board Substrates:  Do not begin paint application until finishing compound is dry and sanded smooth.

3.3  APPLICATION

A.  Apply paints according to manufacturer's written instructions.
   1.  Use applicators and techniques suited for paint and substrate indicated.
   2.  Paint surfaces behind movable equipment and furniture same as similar exposed surfaces.  Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   3.  Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

B.  If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

D. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
   1. Mechanical Work:
      a. Uninsulated metal piping.
      b. Uninsulated plastic piping.
      c. Pipe hangers and supports.
      d. Tanks that do not have factory-applied final finishes.
      e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
      f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
      g. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
   2. Electrical Work:
      a. Switchgear.
      b. Panelboards.
      c. Electrical equipment that is indicated to have a factory-primed finish for field painting.

3.4 CLEANING AND PROTECTION

   A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
   B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
   C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
   D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

   A. Gypsum Board: Provide the indicated "Professional" or "Industrial" coating systems over interior gypsum board and plaster surfaces:
      1. Low-Luster, Acrylic-Enamel Finish: Two finish coats over a primer.
         a. Primer: Latex-based, interior primer; total dry film thickness of not less than 1.2 mils.
         b. Finish Coats: Low-luster (eggshell), acrylic-latex, interior enamel; total dry film thickness of not less than 2.6 mils.
            1) Super Spec Latex Eggshell Enamel 274.
            2) Color: As selected by Owner.
   B. Ferrous Metal: Provide the indicated "Professional" or "Industrial" coating systems over factory-primed ferrous metal:
      1. Semigloss, Acrylic-Enamel Finish: Two finish coats over a factory-applied primer, or indicated primer as applicable.
         a. Primer (for factory-unprimed work): Waterborne, rust-inhibitive, acrylic primer; total dry film thickness of not less than 2.0 mils.
            1) SuperSpec HP Acrylic Metal Primer P04.
         b. Finish Coats: Semi-gloss, acrylic-latex, interior enamel; total dry film thickness of not less than 2.0 mils.
            1) Super Hide Latex Semi-Gloss Enamel 283.
            2) Color: As selected by Owner.
3.6 PIPE IDENTIFICATION COLOR SCHEDULE

A. Identify exposed pipes with the following colors.
   1. Colors are from the Tnemec Colorbook color card.
   2. Equivalent colors of other Manufacturers indicated in Part 2 of this Section may be used.

B. Where a facility has an existing identification system already in use, coordinate with the system in use.

C. In situations where 2 colors do not have sufficient contrast to easily differentiate between them, paint a 6-inch band of contrasting color at 30-inch intervals.

<table>
<thead>
<tr>
<th>Piping</th>
<th>Color Description</th>
<th>Tnemec Colorbook ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>Orange/Red with Black Bands</td>
<td>International Orange 05SF with Black Bands</td>
</tr>
<tr>
<td>Potable Water</td>
<td>Blue</td>
<td>Safety Blue SC06</td>
</tr>
<tr>
<td>Nonpotable Water</td>
<td>Blue with Black Bands</td>
<td>Safety Blue SC06 with Black Bands</td>
</tr>
<tr>
<td>Heating Hot Water (Supply)</td>
<td>Blue</td>
<td>Safety Blue SC06</td>
</tr>
<tr>
<td>Heating Hot Water (Return)</td>
<td>Blue</td>
<td>Safety Blue SC06</td>
</tr>
<tr>
<td>Steam/Condensate</td>
<td>Orange</td>
<td>Safety Orange 04SF</td>
</tr>
<tr>
<td>Chilled Water Supply/Return</td>
<td>Blue</td>
<td>Safety Blue SC06</td>
</tr>
<tr>
<td>Condenser Water Supply/Return</td>
<td>Green</td>
<td>Safety Green 09SF</td>
</tr>
<tr>
<td>Fire Protection</td>
<td>Red</td>
<td>Safety Red 06SF</td>
</tr>
<tr>
<td>Sanitary/Sewage Lines</td>
<td>Dark Gray</td>
<td>Gray 33GR</td>
</tr>
<tr>
<td>Compressed Air</td>
<td>Green</td>
<td>Safety Green 09SF</td>
</tr>
<tr>
<td>Drain Lines, Vent Lines</td>
<td>Gray</td>
<td>Slate Gray 31GR</td>
</tr>
<tr>
<td>Other Lines</td>
<td>Gray</td>
<td>Slate Gray 31GR</td>
</tr>
</tbody>
</table>

END OF SECTION 09 91 00
SECTION 10 14 01 - INTERIOR SIGNAGE

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 SECTION INCLUDES
A. Accessible room and door signs.
B. Interior directional and informational signs.

1.3 REFERENCE STANDARDS

1.4 SUBMITTALS
A. See Section 01 33 00 - Submittal Procedures, for submittal procedures.
B. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.
C. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors. Submit for approval by Owner through Architect prior to fabrication.
D. Samples: Submit two samples of each type of sign, of size similar to that required for project, illustrating sign style, font, and method of attachment.
E. Selection Samples: Where colors are not specified, submit two sets of color selection charts or chips.
F. Verification Samples: Submit samples showing colors specified.
G. Manufacturer's Installation Instructions: Include installation templates and attachment devices.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Package signs as required to prevent damage before installation.
B. Package room and door signs in sequential order of installation, labeled by floor or building.
C. Store tape adhesive at normal room temperature.
1.7 FIELD CONDITIONS

A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.

B. Maintain this minimum temperature during and after installation signs.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Flat Signs:
   5. Substitutions: Not permitted.

2.2 SIGNAGE APPLICATIONS

A. Accessibility Compliance: Signs are required to comply with ADA Standards and ICC A117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.
   1. Where combinations of lines of text, pictograms, and/or braille will result in sign sizes larger than those scheduled, coordinate with the Architect to resolve one size for each signage type so affected.

B. The following types of signs shall include a pictogram of the International Symbol of Accessibility: Accessible entrances where not all entrances are accessible.

C. Accessible Room and Door Signs: Provide a sign for every doorway, whether it has a door or not, not including corridors, lobbies, and similar open areas.
   1. Sign Type: Flat signs with clear panel media with color applied to reverse side.
   2. Provide “tactile” signage, with letters raised minimum 1/32 inch and Grade II braille.
   3. Character Height: 1 inch.
   4. Sign Size: As scheduled.
   5. Room Doors: Identify with room names and numbers to be determined later, not those shown on the drawings.
   6. Raised Character and Braille Exit Signs: Identify with the text "EXIT" and braille.
      a. Provide at the interior side of each doorway to an exit ramp or exit discharge.

D. Interior Directional and Informational Signs:
   1. Sign Type: Same as room and door signs.
   2. Sizes: As indicated on the drawings.
   3. Wording of signs is scheduled on the drawings.
   4. Where signs are scheduled to provide direction to accessible elements, include a directional arrow.
   5. Where suspended, ceiling mounted, or projecting from wall signs are indicated, provide two-sided signs with same information on both sides.
   6. Accessible Means of Egress: Directional signage indicating the location of the other means of egress and which are accessible means of egress shall be provided at the following:
      a. At exits serving a required accessible space but are not providing an accessible means of egress.
   7. Accessible Elements: Directional signage indicating route to nearest like accessible element shall be provided at the following locations:
      a. Inaccessible building entrances.
      b. At exits serving a required accessible space but not providing an approved accessible means of egress.
8. Live Load Design: As scheduled, for each floor or portion thereof of a commercial or industrial building that is or has been designed to exceed 50 psf live load capacity, provide a sign identifying the live load design capacity.

9. Fire-Resistance Ratings: Identification signs for fire walls, fire barriers, fire partitions, smoke barriers, and smoke partitions:
   a. Refer to wall stenciling in Section 09 91 23 Interior Painting.

2.3 SIGN TYPES

A. Flat Signs: Signage media without frame.
   1. Edges: Square.
   2. Corners: Radiused.

B. Color and Font: Unless otherwise indicated:
   1. Character Font: Helvetica, Arial, or other sans serif font.
   2. Character Case: Upper case only.
   3. Background Color: As scheduled.
   4. Character Color: Contrasting color, as scheduled.

2.4 ACCESSORIES

A. Tape Adhesive: Double sided tape, permanent adhesive.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install neatly, with horizontal edges level.

C. Locate signs where indicated:
   1. If no location is indicated obtain Owner's instructions.
   2. All tactile signs shall be mounted with the tactile characters between 48 inches above the floor to the baseline of the lowest characters and a maximum of 60 inches above the floor to the baseline of the highest characters.
   3. All tactile signs shall be mounted with the braille characters between 48 inches and 60 inches above the floor to the baseline of the braille cells.
   4. All tactile signs shall be located with a clear floor area of a minimum 18 x 18, centered on the tactile characters, and clear of any door swing arc between the door closed position and a 45 degrees open position.
   5. Room and Door Signs: Locate on wall at latch side of door with centerline of sign at 60 inches above finished floor.
      a. If no suitable wall surface is available as directed above, consult with Architect for relocation.
   6. Live Load Design: Locate in a conspicuous place in that part of each story in which they apply.

D. Protect from damage until Substantial Completion; repair or replace damage items.
3.3 SCHEDULE

A. Refer to Sign Schedule on the drawings.

END OF SECTION 10 14 01
SECTION 10 28 00 - TOILET AND BATH 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. This Section includes washroom accessories.

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.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
   1. Identify locations using room designations indicated on Drawings.
   2. Identify products using designations indicated on Drawings.

1.4 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.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.0359-inch minimum nominal thickness.

B. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

2.2 WASHROOM ACCESSORIES

A. Basis-of-Design Product: The design for accessories is based on products indicated on the Drawings. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
   1. Bobrick.
   2. American Specialties, Inc.

2.3 FABRICATION

A. General: 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.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 10 28 00
SECTION 12 21 13 – HORIZONTAL LOUVER BLINDS

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. Horizontal louver blinds with aluminum slats.

B. Related Requirements:
   1. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting horizontal louver blinds and accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For horizontal louver blinds, include fabrication and installation details.

C. Samples: For each exposed product and for each color and texture specified, 12 inches (300 mm) long.

D. Samples for Initial Selection: For each type and color of horizontal louver blind.
   1. Include Samples of accessories involving color selection.

E. Product Schedule: For horizontal louver blinds. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. compliance with NFPA 701, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For horizontal louver blinds to include in maintenance manuals.

1.6 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. Horizontal Louver Blinds: Full-size units equal to 5 percent of quantity installed for each size, color, texture, pattern, and gloss indicated, but no fewer than two units.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver horizontal louver blinds in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.
1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install horizontal louver blinds until construction and wet-work and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where horizontal louver blinds 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 operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain horizontal louver blinds from single source from single manufacturer.

2.2 HORIZONTAL LOUVER BLINDS, ALUMINUM SLATS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
1. CACO Inc. Window Fashions.
3. Levolor Contract; a Newell Rubbermaid company.
4. Springs Window Fashions; SWFcontract.

B. Slats: Aluminum; alloy and temper recommended by producer for type of use and finish indicated; with crowned profile and radius corners.
1. Width: 1/2 to 5/8 inch (13 to 16 mm) 1 inch (25 mm) 1-3/8 inches (35 mm) 2 inches (51 mm) Insert dimension.
2. Thickness: Manufacturer's standard Not less than 0.006 inch (0.15 mm) Not less than 0.008 inch (0.20 mm) Insert thickness.
3. Spacing: Manufacturer's standard.
5. Features:
   a. Lift-Cord Rout Holes: Minimum size required for lift cord and located near back (outside) edge of slat to maximize slat overlap and minimize light gaps between slats.

C. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrails fully enclose operating mechanisms on three sides.
1. Capacity: One blind per headrail unless otherwise indicated.
2. Ends: Manufacturer's standard capped.
3. Manual Lift Mechanism:
   a. Lift-Cord Lock: [Variable; stops lift cord at user-selected position within blind full operating range] [Top locking; stops lift cord when blind is in fully opened or fully closed positions only; equipped with ring pull not more than 4 inches (100 mm) long].
   b. Operator: Extension of lift cord(s) through lift-cord lock mechanism to form cord pull.
   a. Tilt: Full.
   b. Tilt: One-direction, positive stop or lockout limited at an angle of 60 degrees from horizontal, both directions.
   c. Operator: Corrosion-resistant steel rod
d. Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over rotation of gear.

5. Manual Lift-Operator and Tilt-Operator Lengths: Full length of blind when blind is fully closed

6. Manual Lift-Operator and Tilt-Operator Locations: Right side and left side of headrail, respectively, unless otherwise indicated.

7. Integrated Headrail/Valance: Curved face.

D. Bottom Rail: Formed-steel or extruded-aluminum tube that secures and protects ends of ladders and lift cords and has plastic- or metal-capped ends.
   1. Type: Manufacturer's standard.

E. Lift Cords: Manufacturer's standard braided cord.

F. Ladders: Evenly spaced across headrail at spacing that prevents long-term slat sag.
   1. Type: Braided cord.

G. Valance: Two slats.

H. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.
   1. Type: Wall.
   2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by blind manufacturer for weight and size of blind.

I. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard. Provide hold-downs hardware, but verify if desired by Owner prior to installation.

J. Colors, Textures, Patterns, and Gloss:
   1. Slats: [As selected by Architect from manufacturer's full range
   2. Components: Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated.

2.3 HORIZONTAL LOUVER BLIND FABRICATION

A. Product Safety Standard: Fabricate horizontal louver blinds to comply with WCMA A 100.1 including requirements for corded, flexible, looped devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):
   1. Outside of Jamb Installation: Width and length as indicated, with terminations between blinds of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

C. Concealed Components: Noncorrodioble or corrosion-resistant-coated materials.

D. Mounting and Intermediate Brackets: Designed for removal and reinstallation of blind without damaging blind and adjacent surfaces, for supporting blind components, and for bracket positions and blind placement indicated.

E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, [locations of connections to building electrical system,] and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install horizontal louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units according to manufacturer’s written instructions.
   1. Install mounting and intermediate brackets to prevent deflection of headrails.
   2. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

3.3 ADJUSTING

A. Adjust horizontal louver blinds to operate free of binding or malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

A. Clean horizontal louver blind 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 ensures that horizontal louver blinds are without damage or deterioration at time of Substantial Completion.

C. Replace damaged horizontal louver blinds that cannot be repaired in a manner approved by Architect before time of Substantial Completion.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain systems.

END OF SECTION 12 21 13
SECTION 12 24 13 - ROLLER WINDOW SHADES

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 manually operated roller shades for windows with single rollers.

B. Related Requirements:
   1. Division 07 Section "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

C. Samples: For each exposed product and for each color and texture specified, 10 inches long.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of shadeband material.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roller shades to include in 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. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than one unit.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.
1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry 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 operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers offering products that may be incorporated into the Work:

1. BTX Window Automation Inc.
2. CACO, Inc., Window Fashions.
3. DFB Sales Inc.
4. Draper Inc.
7. Lutron Electronics Co., Inc.
8. MechoShade Systems, Inc.
9. OEM Shades Inc.
10. Qmotion Shades.
11. Silent Gliss.
12. SM Automatic, Inc.
13. Springs Window Fashions; SWFcontract.

B. 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. Loop Length: [ Full length of roller shade ] [ As indicated on Drawings ].
   b. Limit Stops: Provide upper and lower ball stops.
   c. Chain-Retainer Type: [ Clip, jamb mount ] [ Chain tensioner, jamb mounted ] [ Chain tensioner, sill mounted ].

2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.
   a. Provide for shadebands that weigh more than [10 lb ] [ Insert value ] or for shades as recommended by manufacturer, whichever criterion is more stringent.

C. Crank-and-Gear Operating Mechanisms: Sealed gearbox drive system controlled by crank handle.

1. Crank-Handle Type: [ Detachable ] [ Permanently mounted ].
2. Crank-Handle Length: [ 6 feet ] [ 10 feet ] [ Manufacturer's standard ] [ As indicated on Drawings ].
D. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
   1. Roller Drive-End Location: Right side of interior face of shade.
   2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.

E. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

F. Shadebands:
   2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
      a. Type: Enclosed in sealed pocket of shadeband material.
      b. Color and Finish: As selected by Architect from manufacturer's full range.

G. Installation Accessories:
   1. Front Fascia: Aluminum extrusion that conceals front of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
      a. Shape: L-shaped.
      b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches.
   2. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 SHAEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701 Insert requirement. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
   1. Source: Roller shade manufacturer.
   2. Type: Woven PVC-coated fiberglass and PVC-coated polyester.
   4. Thickness: ________.
   5. Weight: _____ oz./sq. yd.
   6. Roll Width: Full width of existing window openings.
   7. Openness Factor: 1 3 5 10 11 22.
   8. Color: As selected by Architect from manufacturer's full range Insert color.

2.4 ROLLER SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
   1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side, plus or minus 1/8 inch. Length equal to head-to-sill of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:
   1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance of the Work.
   B. 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.
   B. Roller Shade Locations: At exterior windows as indicated on Drawings

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 a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION 12 24 13
SECTION 12 36 41 - SOLID-SURFACE COUNTERTOPS

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 solid-surface-material for use as window sills in existing window openings.

1.3 ACTION SUBMITTALS
A. Product Data: For countertop materials.
B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, and methods of joining.
C. Samples for Verification: For countertop material, 6 inches square.

1.4 PROJECT CONDITIONS
A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.5 COORDINATION
A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID-SURFACE-MATERIAL WINDOW SILLS
A. Configuration: Provide window sills with the following front profile style:
   1. Front: Bullnose.
B. Thickness: 1/2-inch thick, solid surface material with front edge built up to 1-inch thickness with same material.
C. Fabrication: Fabricate tops in one piece with shop-applied edges unless otherwise indicated. Comply with solid-surface-material manufacturer’s written instructions for adhesives, sealers, fabrication, and finishing.
   1. Fabricate with loose backsplashes for field assembly.

2.2 COUNTERTOP MATERIALS
A. Particleboard Subtop: ANSI A208.1, Grade M-2 Glue.
B. Solid Surface Material: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1.
   1. Manufacturers: As indicated on Drawings.
   2. Type: Provide Standard Type unless Special Purpose Type is indicated.
   3. Colors and Patterns: As indicated on Drawings.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install window sills level to a tolerance of 1/8-inch in 8 feet.

B. Fasten subtops to existing wall by screwing through subtops into existing wall blocking. Shim as needed to align subtops in a level plane.

C. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer’s written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

D. Install backsplashes and endsplashes to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

E. Seal edges of cutouts in particleboard subtops by saturating with varnish.

F. Apply sealant to gaps at walls; comply with Division 07 Section "Joint Sealants."

END OF SECTION 12 36 41
SECTION 22 05 00 – GENERAL PLUMBING PROVISIONS

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 specifying the general requirements for execution of that portion of the Work defined in Division 22 of these Specifications and as indicated on the Drawings:

1. Major items include, but are not necessarily limited to:
   a. Cutting and patching.
   b. Concrete foundations and support steel.
   c. Piping, fittings and valves.
   d. Piping and equipment insulation.
   e. Temperature and pressure gages.
   f. Excavation and backfilling required.
   g. Plumbing equipment.
   h. Demolition of existing plumbing work.
   i. Labor, materials, equipment, tools, supervision and start-up services.
   j. Instructions to Owner regarding operation.
   k. Incidental and related items necessary to a complete and functionally operational installation of the Work.

B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the Work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the Work:

1. General Contractor:
   a. Install access doors.
   b. Provide concrete isolation and housekeeping pads for plumbing equipment.
   c. Refer to Division 01 Section “Cutting and Patching.” Cutting and patching of walls, ceilings, and floors.
   d. Provide access doors in walls and ceilings for access to plumbing equipment.

2. Plumbing Subcontractor:
   a. Refer to Division 01 Section “Cutting and Patching.” Bear financial responsibility for cutting and patching of walls, ceilings, and floors for Division 22 Work.
   b. Furnish location, size and quantity of openings to Contractor before construction of new walls, ceilings, and floors.
   c. Furnish size and locations of concrete equipment isolation and housekeeping pads as required for this Work and as indicated on the Drawings to Contractor before slabs are poured.
   d. Furnish size and location of access doors required for this work as indicated on the Drawings to Contractor.
   e. Provide excavation and backfilling required in connection with the Work of Division 22.
   f. Provide miscellaneous structural steel required in connection with support of the Work of Division 22.
   g. Perform final cleaning of plumbing systems and equipment.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of Division 22 shall comply with the following:

1. ANSI:
2. ASME: B31.9 - Building Services Piping.
5. Michigan:

1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. Construction details, components, accessories, sizes and model numbers indicated on the Drawings or in these specifications are used to indicate minimum levels of quality and coordination requirements.

B. Equipment supplied, whether as scheduled or selected from list of acceptable Manufacturers, must meet minimum requirements listed in specifications or on Drawings, be compatible with facility and intended use, and meet requirements for a functional system.

C. Drawings:
   1. Are diagrammatic and indicate general arrangement of systems and work included.
   2. Do not necessarily indicate every required valve, fitting, trap, thermometer, gage, duct, elbow, transition, turning vane, mounting support and access panel.
   3. Shall not be scaled for measurement or installation location.
   4. Shall not serve as Shop Drawings.

D. Schedules and model numbers shall not be used to:
   1. Serve as final, definitive quantity requirements. Contractor shall make own count as indicated on Drawings.
   2. Determine proper type or model with arrangement, mounting and accessories applicable.

E. Coordinate installation work of Division 22 with work of other trades to provide a complete and functional system. Generally, the location of ductwork, sanitary, storm and vent piping take precedence over fire protection and HVAC piping, electrical conduit and cable trays.

1.5 QUALITY ASSURANCE

A. Comply with all State and Local requirements.

B. All products and components that conveys or dispenses water for human consumption through drinking or cooking must comply with US SWDA – 2014, NSF 61- 2012, and NSF 372-2011.
   1. Compliance must be certified and labeled by an independent accredited testing agency.

1.6 PRODUCT UNLOADING AND HANDLING

A. Unload equipment and materials required for completion of the Work.

B. Handle and store equipment and materials carefully to prevent damage. Method of rigging and handling shall be subject to the approval of an authorized representative of the equipment Manufacturer whose equipment is being handled.

1.7 TROUBLESHOOTING

A. By Contractor: If, during the start-up or warranty period, mechanical systems operational problems occur for which the root cause is not readily apparent, Contractor shall promptly, through a Subcontractor or other resource designated by Subcontractor, provide diagnostic and investigative services to determine the cause or causes.
B. By Engineer:
1. At Contractor's request, Engineer will provide the services necessary to determine the cause or causes of the operational problems.
2. Under the provisions of the General Conditions, Engineer will also provide these services if Contractor fails to respond satisfactorily to operational problems within a reasonable time after written notice from Engineer.
3. If while working at Contractor's request or under the provisions of the General Conditions, Engineer determines that the problems are due to failure of the Work to comply with the requirements of the Contract Documents, Owner will compensate Engineer for additional services and deduct the amount paid from payment or payments to Contractor.

1.8 MAINTENANCE
A. Special Tools: Where special tools are required for operation, furnish these to Owner.
B. Loose and Detachable Parts:
1. Retain loose and small detachable parts of the apparatus and equipment furnished until the completion of the Work.
2. Turn over these parts to Owner.
C. Construction Strainers:
1. Remove after flushing and cleaning and prior to turn over to Owner.
2. Attach removed construction strainer to piping where removed as proof of removal.

PART 2 - PRODUCTS
2.1 FABRICATIONS
A. Miscellaneous Structural Steel:
1. Comply with the requirements of Division 05 Section "Metal Fabrications," where applicable.
2. Structural steel work shall be done in accordance with the AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings, except that allowable stresses shall be reduced 25%.
3. Where required, high strength structural steel bolting conforming to ASTM Specification A325 and assembled to AISC "Specifications for Assembly of Structural Joints. Using High Strength Steel Bolts" or welding shall be used in place of rivets.
4. Connections shall be properly designed for the type of connection and the loads to be carried, and shall be subject to Engineer's or Owner's approval.
5. Welding shall be done by operators who have been previously qualified by tests as prescribed in the American Welding Society "Standard Qualification Procedure" to perform the type of work required.
7. Finished members shall be true to line and free from twist, bends and open joints.
B. Material installed in a ceiling plenum shall be either noncombustible or have a maximum flame spread of 25 and a maximum smoke developed rating of 50.

PART 3 - EXECUTION
3.1 INSTALLATION
A. Character of Work: Installation shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed.
B. Laying Out of Work:
1. Layout piping, equipment and components in accordance with the Contract Documents and the Manufacturer's recommended practice, including provision of adequate space for maintenance. Review layout with Engineer prior to installation.
2. Check drawings of other trades to verify spaces in which work will be installed. Maintain maximum head room and space conditions at all points. Where head room or space conditions appear inadequate, notify Engineer before proceeding with installation.

3. If directed by Engineer, Contractor shall make reasonable modifications in the layout as required to permit proper execution of the Work and to prevent conflict with work of other trades.

4. Work shall be installed so as to be ready for operation, maintenance and repair. Minor deviations from Drawings may be made to accomplish this. Changes shall not be made without approval of Engineer.

3.2 EXCAVATING AND BACKFILLING

A. Comply with the requirements of Division 31 Section “Excavation and Fill for Utilities.”

B. Backfill shall be sand backfill. The use of clay, stone, rocks, brickbats, cinders, or frozen sand for backfill will not be permitted.

C. Backfill and fill below structures and pavements shall be compacted to 95% density as determined by ASTM modified proctor.

D. Pipe Bedding Material Shall:
   1. Conform with Manufacturer's recommendations.
   2. Be modified to maximum size of 3/8 inches and compacted to 95% density as determined by ASTM modified proctor; or pea gravel with best compaction possible to provide firm continuous support.
   3. Run full width of trench from minimum 4 inches below pipe to 12 inches above pipe.

3.3 MODIFICATIONS TO EXISTING FACILITIES

A. Comply with the requirements of Division 02 Section “Demolition” for removal of existing pipes, equipment, and other systems.

B. Comply with the requirements of Division 02 Section “Selective Demolition,” for all work related to the modification, alteration, conversion, renovation and reuse of existing facilities.

3.4 PIPE FITTINGS

A. Provide insulating couplings or unions where dissimilar materials are joined.

B. Provide unions at valves and at equipment for making repairs.

3.5 CODING AND TAGGING

A. Piping:
   1. Applied to new piping after installation, insulation, and final painting.
   2. Conform to Owner’s existing standards or conventions.
   3. Markings:
      a. Painted on, 1-inch high black letters.
      c. Directional arrow.
   4. Place markers at 20-foot centers with at least 1 in each room, and at every change in direction.
   5. For external diameters less than 6 inches (including insulation, if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
      a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
      b. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4-inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inches.
   6. Large Pipes: For external diameters of 6-inch and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
      a. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inches wide, full circle at both ends of pipe marker, tape lapped 3 inches.
b. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
7. Plastic coated "Set Mark-Snap-Around" pipe markers manufactured by Seton Name Plate Corp., New Haven, Connecticut; or approved equal, may be used in lieu of painted markers and bands.

B. Valves:
1. Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp engraved piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2-inch high, and with 5/32-inch hole for fastener.
   a. Provide 1-1/2-inch diameter tags, except as otherwise indicated.
   b. Provide size and shape as specified or scheduled for each piping system.
   c. Fill tag engraving with black enamel.
2. Furnish schedule(s) of tagged valves with number, location and purpose of each valve.
3. Schedule shall be typewritten on 8-1/2-inch x 11-inch bond paper.
4. Tabulate valve number, piping system, system abbreviation (as indicated on tag), location of valve (room or space utilizing WSU's official room numbering scheme) and variations for identification (if any); Require the marking of valves which are intended for emergency shut-off and similar special uses by special flags in margin of schedule. In addition to mounted copies, require the furnishing of three extra copies for Maintenance Manuals, as well as the electronic document file in Microsoft Excel or Word.
5. Place a copy of each schedule:
   a. In the Maintenance Instructions.
   b. In a string tie envelope labeled "Valve Schedule" and mount on the wall in Electrical Room 204.

C. Where valves are located above the ceilings, a cadmium plated screw shall be located in the ceiling tile directly below the device.

D. Equipment:
1. Provide for:
   a. Each water heater.
   b. Labeled with its tag name/number as given on the Drawings.
   c. Use 2-inch high stenciled painted lettering.
2. Similarly label control components associated with the above named equipment items.

3.6 START-UP
A. Comply with the requirements of Division 01 Section “Starting and Adjusting.”

3.7 ADJUSTING
A. Adjust and align equipment for smooth operation:
1. Plumb true and with parts in proper position and alignment.
2. Rotating parts shall turn freely and in the correct direction.
3. Flexible couplings shall be checked for alignment subject to Owner's approval.
4. Follow Manufacturer's instructions.
B. The work of installation shall be executed in conformity with the best practice, so as to contribute to efficiency of operation, minimum noise or vibration, minimum maintenance, accessibility and sightlines.

3.8 FIELD QUALITY CONTROL
A. Manufacturer's Field Services:
1. Provide when required by individual Section.
2. Provide the following services except where indicated otherwise in individual Sections:
   a. Inspect, check and approve system installation.
   b. Supervise system start-up.
   c. Provide written report indicating that system:
      1) Has been properly installed and lubricated.
      2) Is in accurate alignment.
3) Is free from undue stress imposed by connecting lines or anchor bolts.
4) Has been satisfactorily operated under full load conditions.

d. Demonstrate operation of system to Owner's personnel.
e. Instruct Owner's personnel on operation and maintenance of system.

B. Performance Test:
1. Test the entire Work, including all of its individual systems for 2 weeks before final payment will be made.
2. Every phase of plumbing plant shall be operated separately, or in conjunction one with the other to demonstrate to Engineer the ability of the plant to meet capacity and performance requirements while maintaining design condition, in accordance with the true intent and purpose of these Specifications.
3. Make final tests in the presence of Owner and Engineer.
4. If a part of the Work or equipment does not meet Specifications:
   a. Correct the situation.
   b. Obtain approval of Engineer before final payment is made.
5. Provide the personnel and bear costs for correcting malfunctions.
6. Owner will provide operating personnel and utilities.

C. Comply with the requirements of Division 01 Section "Starting and Adjusting."

3.9 CLEANING AND FINISHING

A. Comply with the requirements of Division 01 Section "Cleaning and Waste Management."

B. Entire installation shall be free from surface oil and grease before work will be considered for final payment.

C. After tests have been made and the system pronounced tight:
   1. Clean piping and equipment.

D. Final cleaning includes but is not limited to the following:
   1. Equipment with Factory Finishes:
      a. Wash factory-finished equipment with mild soap and water and leave in first-class condition, entirely free of stains or streaks.
      b. Do not use abrasive materials. Touch up scratches or other violations of the factory finish paint with matching paint from the equipment Manufacturer prior to cleaning.
   2. Plumbing Fixtures:
      a. Clean with mild soap and water containing a disinfecting agent.
      b. Set trim handles at same angle and polish.
      c. Remove, clean and reinstall aerators.
      d. Check pop-up wastes for proper operation.
   3. Clean floor drains and leave free of foreign material.

END OF SECTION 22 05 00
SECTION 22 05 03 – STEEL PIPE AND FITTINGS 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. This Section includes the basic requirements of steel pipe and fittings. Refer to Division 22 Section "Plumbing Piping and Specialties" for project specific requirements.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:

1. ANSI Standards:
   b. B16.4 - Cast-Iron Threaded Fittings, Class 125 and 250.
   c. B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloys and Other Special Alloys.
   e. B16.11 - Forged Steel Fittings, Socket Welding and Threaded.
   f. B16.21 - Nonmetallic Flat Gasket for Pipe Flanges.
   g. B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
   h. B18.2.2 - Square and Hex Nuts.
   i. B31.9 - Building Services Piping.

2. American Society of Mechanical Engineers (ASME) publications:

3. ASTM Standards:
   a. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   b. A105 - Forgings, Carbon Steel, for Piping Components.
   c. A106 - Seamless Carbon Steel Pipe for High-Temperature Service.
   e. A181 - Forgings, Carbon Steel for General Purpose Piping.
   f. A197 - Cupola Malleable Iron.
   g. A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
   i. A 307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile.
   j. A312 - Seamless and Welded Austenitic Stainless Steel Pipe.

1.4 SUBMITTALS

A. Submit Manufacturer's Literature: For steel pipe and fittings. Include Manufacturer name, Manufacturer location, dimensions, and details of construction and installation.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

B. Labeling: Piping materials shall bear the label, stamp or other marking of all specified standards and testing compliance.
C. Testing of Steel Piping: In accordance with Division 22 Section “Testing and Cleaning of Plumbing Systems.”

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
1. Except as herein specified or as indicated on the Drawings, all materials shall be in accordance with the Piping Systems Schedule in Part 3 of the appropriate applicable specification section.
2. Pipe 6'-0" and longer shall be permanently marked with the following information:
   a. Manufacturer's name.
   b. Pressure rating.
   c. Size.
3. All pipe joints shall be welded for pipe sizes 2-1/2 inches and larger.

B. Black Steel Pipe:
1. Black steel pipe shall be welded or seamless carbon steel, as specified for the type of service.
2. Welded black steel pipe shall meet the requirements of ASTM A53 or A106, and shall be Type F continuous-weld furnace butt-welding (CW), or Type E electric resistance welded (ERW) Grade B.
3. Seamless black steel pipe shall meet the requirements of ASTM A53 or A106, Type S seamless, Grade A or B.

C. Buried Piping:
1. Wrap with a pressure sensitive, adhesive backed, polyvinyl chloride or polyethylene tape:
   a. Spirally wrap straight pipe with 0.020-inch thick tape with minimum overlap of 1/2-inch.
   b. Spirally wrap 2 layers of 0.010 thick tape with minimum overlap of 1/2-inch.
   c. Manufacturers: 3M Company “Scotchwrap”; or approved equal.
2. Steel pipe with a factory applied polyethylene plastic coating such as Energy Coatings Company, "Pritec" may be used in lieu of wrapping specified above.

2.2 FITTINGS

A. Unions:
1. Pipe Sizes 2 Inches and Smaller:
   a. Forged steel with ground joint.
   b. Properly fitted for design temperature and pressure.
   c. 2000 pound rated equal to Crane No. 250H or 251H.
   d. 3000 pound rated equal to Crane No. 252H.
2. Pipe Sizes 2-1/2 Inches and Greater: Use companion flanges where unions are required.

B. Screwed Fittings:
1. Cast iron in accordance with ANSI B16.4.
2. Nodular or ductile iron in accordance with ASTM A395.

C. Welding Fittings:
1. Meet ASTM A234 symbol WPA or WPB.
2. The A or B grade shall conform to the grade of pipe used with the fittings.
3. Dimensional standards shall conform to ANSI B16.9.

D. Flanges:
1. General:
   a. Welding neck or slip-on type with raised face.
   b. Conforming to ANSI B16.5.
   c. Class 150 and 300 conforming to ASTM A181, Grade I.
   d. Class 600 and 900 conforming to ASTM A105, Grade II.
2. Use threaded or socket weld type for piping smaller than 2-1/2 inches.
3. Use flat face steel flanges when matching cast iron companion flanges.
E. Flange Gaskets:
1. Nonasbestos compressed material conforming to ANSI B16.21 and suitable for 600 degrees F service.
2. Ring type, 1/16-inch thickness.
3. Spiral wound stainless steel for service over 300 psi.
4. Use full face gaskets with flat face flanges.

F. Bolting Material:
1. General:
   a. Carbon steel, square-head bolts and Grade 2H hex nuts.
   b. Bolt length shall be sufficient to extend completely through nut with maximum 3/8-inch projection.
   c. Dimensions conforming to ANSI B18.2 (bolts) and ASTM A194 (nuts).
2. Bolts:
   a. For service below 250 psig/450 degrees F, use Grade B conforming to ASTM A307.
   b. For service at or above 250 psig/450 degrees F, use Grade B7 conforming to ASTM A193.

G. Socket Welding Fittings: All forged steel socket-welding fittings shall conform to ANSI Standard B16.11 ASTM A105 Gr. II, equal to Crane 3,000-pound forged fittings.

2.3 MECHANICAL PIPING COUPLINGS

A. Manufacturers:
1. Victaulic.
2. Anvil.
3. Or approved equal.

B. General:
1. All grooved piping materials shall conform with the specifications governing the systems or application for which they are used.
2. All couplings and fittings shall be finished with hot-dip galvanizing of alkyd enamel paint.

C. Pipe and Tubing:
1. Standard Weight Steel Pipe:
   a. Comply with the requirements of Division 22 Section “Steel Pipe and Fittings for Plumbing.”
   b. ASTM Schedule 40, A53 black steel or hot-dipped zinc-coated.

D. Couplings:
2. Style: Standard Steel Pipe:
   a. Rigid style.
   b. Victaulic “Zero-Flex” style 07; Grinnell style 772.
3. Gasket:
   a. Water Service: EDPM.
   b. Chemical Service: VITON.
   c. Oil, Air and Vacuum Service: Nitrile.
4. O-rings (Thin Wall Only):
   a. Water Service: Grade C butylenes.
   b. Chemical Service: Not acceptable.
   c. Oil Service: Not acceptable.
   d. Air and Vacuum Service: Not acceptable.
5. Bolts – Nuts:
   a. Track bolts with 110,000 psi tensile strength.
   b. Heavy hex nuts.
   c. Zinc electroplated carbon steel.

E. Fittings:
1. Steel, ductile iron, copper or bronze.
2. Grooves or shoulders compatible with system couplings.
3. Segmentally welded fittings not acceptable.
4. Clamp-on mechanical tees not accepted.
F. Valves:
1. Refer to Division 22 Section “General Duty Valves for Plumbing,” or specification section governing the system or application for which they are used.
2. Compatible with grooved pipe coupling.

G. Strainers:
1. Refer to Division 22 Section “Plumbing Piping and Specialties.”
2. Compatible with grooved pipe coupling.

PART 3 - EXECUTION

3.1 PREPARATION

A. During Freezing Weather:
1. Protect all materials in such a manner that no harm can be done to:
   a. Installations already made.
   b. Materials and equipment on the Site.
2. Furnish all necessary protection for such installations and equipment as may be required.

3.2 ERECTION

A. General:
1. All Piping: Follow approved paths as indicated on the Drawings.
2. Connect to existing lines where required, or to equipment in an approved manner.
3. Locate Pipes, Valves and Equipment to Provide:
   b. Minimum obstruction of passageways and working space.
4. Normally, all pipe runs shall be plumb, parallel with the building and level, except for drain slope.
5. Be responsible for establishing and maintaining drain slope of piping in order to ensure drainage.
6. Expansion of Piping:
   a. All pipe connections shall provide freedom of movement of the piping during expansion and contraction without springing of piping or injury to building steel or structure.
   b. Any damage to building steel or structure as a result of work installed by Contractor shall be repaired at Contractor's expense.
7. As Piping Material is Erected:
   a. Thoroughly clean the inside of all piping.
   b. Remove foreign material such as scale, sand, weld spatter, particles and cutting chips.
8. Provide caps or plugs in all openings at the end of each day's work and as otherwise directed for the protection of the piping. Particular attention must be given to avoid the possibility of any foreign material entering the pipes.
9. Flanges shall be made on pipe so that the gasket surface forms an angle of 90 degrees with the pipe axis. Screwed flanges shall be made on until the pipe projects through the flanges and then the flanges must be refaced.

B. Sleeves and Holes:
1. Contractor shall be responsible for cutting required holes and openings in floors, walls and other structures, except as noted on the Drawings. Sleeves will be placed by Contractor in all such openings, and no holes shall be cut without Owner's approval. Sleeves shall be in accordance with the standard details included in the Drawings.
2. All holes in floors, walls, roofs, etc., where pipe lines or other materials have been removed or installed, shall be neatly and properly filled with concrete, brick or other material in accordance with the general character of the construction at the location.

C. Unions and Eccentric Fittings:
1. Unions shall be provided at each screwed valve and where their use will facilitate dismantling of the piping and as required or directed in special cases.
2. Eccentric fittings or eccentric reducing couplings shall be provided in all cases where air or water pockets would otherwise occur in the main due to the reduction in pipe size.
D. **Pipe Joints:**
1. Pipe connections at all valves shall be mechanically joined unless otherwise indicated on the Drawings or reviewed by Owner or Engineer.
2. Pipe joints which will be buried or otherwise concealed shall be welded regardless of size.
3. Mitered joints shall not be permitted.
4. In general, black steel 2-1/2-inch and larger shall be welded except that a flange or union shall be provided at all valves and at equipment.
5. The connections to welded 2-1/2-inch and larger pipe shall be made with a welding tee or Weld-o-let of butt, socket or threaded type as required. Scarf welding of side connections shall not be permitted.
6. Only welding ells shall be used for changing pipe directions of welded pipe lines.

E. **Pipe Welding:**
1. Where welding is called for, it shall be of the fusion process and shall consist of welding by means of either the oxyacetylene or electric arc process.
2. All welding shall conform to the ASME Boiler and Pressure Vessel Code or the ANSI Code for Pressure Piping. All welders shall be qualified in accordance with ASME Standard Qualifications for Welding Procedures, Welders and Welding Operators, or Section 9 of the ASME Boiler and Pressure Vessel Code for the class of piping being welded. Submit welding qualifications for all welders on the Project when requested by Engineer.
3. Each welded joint shall have the welder's initials, last 2 numbers of the year and a symbol indicating whether backing rings were used or not. All marks shall be located where easily accessible according to the following order or preference: Top center, north, east, south and west.

### 3.3 MECHANICAL COUPLING SYSTEMS

A. Piping shall be prepared in accordance with the latest Manufacturer's specifications or other standards applicable.

B. Standard weight (Schedule 40 or heavier) steel piping may be roll grooved or cut grooved.

C. Couplings, fittings, valves and pipe shall be assembled in accordance with latest Manufacturer's instructions.

D. Support piping according to Manufacturer’s maximum span recommendations or Division 22 Hangers and Supports for Plumbing Piping and Equipment,” whichever is more stringent.

E. Raised face flanges shall have a metal flange washer installed.

F. Cutting, Grooving and Crimping:
1. All flexible pipe fittings including grooved, cut and plain end and all quick fit fittings shall be installed with a machine specifically designed for this purpose.
2. All piping to be grooved, cut and crimped shall be prepared using this specifically designed machine.

G. Mechanical joints are not allowed within walls.

H. **Manufacturer’s Field Service:** Arrange and pay for Manufacturer’s Engineer to provide the installation direction for a minimum onsite time of 1 day.
1. Submit written approval of installation.
### 3.4 APPLICATION SCHEDULE

<table>
<thead>
<tr>
<th>Application</th>
<th>Design Temperature Range</th>
<th>Maximum Pressure</th>
<th>Acceptable Pipe/Coupling (See Note Below)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic hot water</td>
<td>-30 to 230 degrees F</td>
<td>300 psig</td>
<td>B</td>
</tr>
<tr>
<td>Domestic cold water</td>
<td>-30 to 230 degrees F</td>
<td>300 psig</td>
<td>B</td>
</tr>
<tr>
<td>Sanitary drain and vent</td>
<td>-30 to 230 degrees F</td>
<td>300 psig</td>
<td>A</td>
</tr>
</tbody>
</table>

Note – Pipe/Coupling Types:

A. Cast Iron Pipe: Refer to Section 22 05 06 – Cast Iron Pipe and Fittings for Plumbing.
B. Copper Tubing: Refer to Section 22 05 09 – Copper Pipe and Fittings for Plumbing.
NA. Not allowed for this application.

### 3.5 ADJUSTING AND CLEANING

A. Clean and test piping in accordance with Division 22 Section “Testing and Cleaning of Plumbing Systems.”

END OF SECTION 22 05 03
SECTION 22 05 06 – CAST IRON PIPE AND FITTINGS 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. This Section includes the basic requirements of all cast iron pipe and fittings. Refer to Division 22 Section “Plumbing Piping and Specialties” for project specific requirements.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:

1. ASTM Specifications:

2. Cast Iron Soil Pipe Institute (CISPI) Specification:
   b. 310 - CISPI’s Patented Joints for Use in Connection with Hubless Cast Iron Sanitary System.

3. AWWA Standard:
   b. C110 - Gray-Iron and Ductile-Iron Fittings, 3 inches through 48 inches, for water and other liquids.
   d. C151 - Ductile Iron Pipe Centrifugally Cast in metal Molds or Sand Lined Molds for water or other liquids.
   e. C153 - Ductile Iron Compact Fittings, 3-inch through 24-inch.

1.4 SUBMITTALS

A. Submit in accordance with Division 01 Section “Submittal Procedures.”

B. Manufacturer’s Literature: For cast iron pipe and fittings and couplings. Includes Manufacturer name, Manufacturer location, dimensions, and details of construction and installation.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the installation of the material.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

B. Regulatory Requirements: Comply with local code applicable to installation of the material.

PART 2 - PRODUCTS

2.1 HUB AND SPIGOT PIPE AND FITTINGS

A. ASTM A74, push tight resilient joints and fittings. Sanitary class.
B. Gaskets:
   1. ASTM C 564.
   2. Elastomeric double seal compression type.

C. All pipe and fittings shall be made in the United States and bear the CISPI trademark.

2.2 HUBLESS PIPE AND FITTINGS

A. ASTM A888 and CISPI 301.

B. Couplings:
   1. ASTM C1277 Couplings.
   2. ASTM C1540 Heavy Duty Couplings.
   3. Corrosion resistant fasteners.
   4. ASTM C564 rubber sleeve with integral, center pipe stop.
   5. Above Ground or Corrosive Soils:
      a. Heavy Duty, Type 304, Stainless Steel Couplings: ASTM A666, Type 304, stainless steel shield; stainless steel bands; and sleeves.
         1) NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 3-inch wide shield with 4 bands.
         2) NPS 5 to NPS 10 (DN 125 to DN 250): 4-inch wide shield with 6 bands.
      b. Heavy Duty, Cast Iron Couplings: ASTM A48, 2 piece, cast iron housing; stainless steel bolts and nuts; and sleeve.

C. All pipe and fittings shall be made in the United States and bear the CISPI trademark.

PART 3 - EXECUTION

3.1 ERECTION

A. System shall be installed in accordance with Manufacturer’s instructions and Code requirements.

B. Hubless piping shall not be used for pressurized or below grade applications.

3.2 JOINTS AND FITTINGS

A. Mitered joints will not be permitted.

B. Joints between CI soil pipe and "DWV" (drain, waste and vent) copper pipe are to be made with calking ferrule for bell and spigot pipe or a compatible adapter for hubless pipe.

C. Pipe and fittings shall be joined by 1 of the following 3 methods:
   1. Calked lead and oakum.
   2. Positive double seal elastomeric compression type gasket.
   3. No hub clamp assembly.

D. Service weight pipe shall be joined with service weight gasket.

E. Use extra heavy gasket with extra heavy pipe.

END OF SECTION 22 05 06
SECTION 22 05 07 – PLASTIC PIPE AND FITTINGS 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. This Section includes the basic requirements of all plastic pipe and fittings used for cooling coil condensate piping. Refer to Division 22 Section “Plumbing Piping and Specialties” for project specific requirements.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ASTM Specifications:
      b. D2466 - Socket-Type Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.

1.4 SUBMITTALS

A. Manufacturer’s Literature: For all plastic pipe and fittings. Include material, properties and dimensions; and identification of piping system(s) for which submitted material will be used.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced with the material and the specialized installation tools.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

B. Regulatory Requirements:
   1. Local codes having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS


2.2 PVC PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D 1785.
   1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.
   2. Use for equipment drain piping above grade.

2.3 IDENTIFICATION

A. Pipe and fittings shall have the following identification printed in indelible ink, hot-stamped or molded:
   1. Manufacturer’s lot number.
   2. Manufacturer’s name or trademark.
   4. Nominal pipe size.
PART 3 - EXECUTION

3.1 ERECTION

A. All piping shall follow approved paths as indicated on the Drawings, connect to existing lines where required, or to equipment in an approved manner.

B. Location of pipe, valves and accessory equipment shall be arranged in the best possible manner, consistent with the Drawings, for accessibility and minimum obstruction of passageways and working space.

C. Pipe runs shall be plumb, parallel with the building and level, except for drain slope.

D. Unless noted otherwise, drain slope shall be a minimum of 1/8-inch per foot, or minimum as required by local plumbing code, whichever is greater, and shall be in the direction of flow where possible.

E. Plastic pipe shall meet local building code erection fire and smoke compliance standards. PVC piping shall not be installed in return air plenum. It shall only be used for cooling coil condensate drainage on rooftop unit drainage.

F. Solvent Cementing:
   1. Plastic pipe to be cut square to allow the pipe to "bottom out" in the socket of the fitting.
   2. The pipe end to be beveled around the outside, and deburred on the inside to allow for proper fit.
   3. The plastic piping and inside of fitting to be cleaned with an approved pipe cleaner to ensure proper bonding of solvent cement.
   4. The jointing surface must be dissolved and made semi-fluid with sufficient solvent cement being applied to both surfaces to fill the gap between pipe and fitting.
   5. There shall not be a ridge of cement around the inside of pipe or fitting.

G. Joints between plastic pipe and copper, steel or cast iron piping to be made with local and state code approved adapters.

H. Approved polypropylene ferrule and slip nut joints may be used for pipe 2-inch or less above floor in equipment or furniture cabinet bases.

I. Heat Fusion:
   1. Use electrical fusing method.
   2. As recommended by Manufacturer.

END OF SECTION 22 05 07
SECTION 22 05 09 – COPPER PIPE AND FITTINGS 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. This Section includes the basic requirements of copper pipe and fittings. Refer to Division 22 Section “Plumbing Piping and Specialties” for project specific requirements.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ASTM Specifications:
      a. B75 - Copper Fittings.
      b. B88 - Seamless Copper Water Tube.
      c. B306 - Copper Drainage Tube (DWV).

1.4 SUBMITTALS

A. Manufacturer's Literature: For copper pipe and fittings. Include material, properties, dimensions, details of construction and installation, name of Manufacturer, model.

B. Manufacturer's literature for couplings and gasketing material.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.
   3. Installer of mechanical coupling piping system must be able to demonstrate a minimum of 5 years successful installation experience.

B. Testing of Copper Piping: In accordance with Division 22 Section “Testing and Cleaning of Plumbing Systems.”

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration and contamination with foreign matter.

C. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace removed materials at no additional cost to Owner.
PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Seamless Copper Tubing:
   1. Factory coded and marked.
   2. Conform to the following schedule:
      a. Aboveground: ASTM B88, Type L, hard drawn.
   3. Pipe Markings:
      a. All piping longer than 2'-0" shall have a permanent marking in accordance with ASTM or ANSI specifications.
      b. This identification shall include the following:
         1) Manufacturer's name.
         2) Pipe pressure rating.
         3) Pipe size.

B. Solder type shall conform to the following schedule:
   1. Hot and Cold Water Lines: 95% tin, bismuth, copper and 5% silver.
      a. IAPMO listed lead free.

C. Fittings:
   1. General Service:
      a. Sweat type, wrought copper, long radius elbows.
      b. Cast fittings shall only be allowed with written permission from the Engineer.
   2. Drainage:
      a. Sweat type, wrought copper, drainage pattern.
      b. Specialty items, such as closet elbows, may be cast brass.

2.2 MECHANICAL COUPLING PIPING SYSTEMS

A. Manufacturers:
   1. Victaulic.
   2. Grinnell.
   3. Or approved equal.

B. Rigid Couplings:
   1. Housing: Ductile iron, ASTM A536; wrought copper or cast bronze.
   2. Style:
      a. Rigid style.
      b. Victaulic CTS style 606.
   3. Gasket:
      a. Water Service: EDPM.
   4. O-rings (Thin Wall Only):
      a. Water Service: Grade C butylenes.
   5. Bolts – Nuts:
      a. Track bolts with 110,000 psi tensile strength.
      b. Heavy hex nuts.
      c. Zinc electroplated carbon steel.

C. Fittings:
   1. Copper or bronze.
   2. Grooves or shoulders compatible with system couplings.
   3. Segmentally welded fittings not acceptable.
   4. Clamp-on mechanical tees not accepted.

D. Valves:
   1. Refer to Division 22 Section “General Duty Valves for Plumbing," or specification section governing the system or application for which they are used.
   2. Compatible with grooved pipe coupling.
PART 3 - EXECUTION

3.1 PREPARATION

A. During Freezing Weather:
   1. Protect all materials in such a manner that no harm can be done to:
      a. Installations already made.
      b. Materials and equipment on the Site.
   2. Furnish all necessary protection for such installations and equipment as may be required.
   3. Grooved system copper piping shall be roll grooved without metal removal.

3.2 ERECTION

A. General:
   1. All Piping: Follow approved paths as indicated on the Drawings.
   2. Connect to existing lines where required, or to equipment in an approved manner.
   3. Locate Pipes, Valves and Equipment to Provide:
      b. Minimum obstruction of passageways and working space.
   4. Normally, all pipe runs shall be plumb, parallel with the building and level, except for drain slope.
   5. Be responsible for establishing and maintaining drain slope of piping in order to ensure drainage.
   6. Expansion of Piping:
      a. All pipe connections shall provide freedom of movement of the piping during expansion and contraction without springing of piping or injury to building steel or structure.
      b. Any damage to building steel or structure as a result of work installed by Contractor shall be repaired at Contractor's expense.
   7. As Piping Material is Erected:
      a. Thoroughly clean the inside of all piping.
      b. Remove foreign material such as scale, sand, weld spatter, particles and cutting chips.
   8. Provide caps or plugs in all openings at the end of each day's work and as otherwise directed for the protection of the piping.

B. Pipe Joints:
   1. Cut ends of copper tubing squarely using only sharp tube cutters.
   2. Ream pipe to full I.D. before preparing the joint.
   3. Soldering:
      a. Solder or braze joints by cleaning outside ends of all copper tubings and inside of fittings immediately before joining and soldering.
      b. Apply solder flux to both tube and fitting.
      c. Insert tube full depth into fitting, apply heat and solder in such a manner as to draw solder into and completely around the joint.
   4. Joining Valves:
      a. When joining copper lines to valves follow Manufacturer's instructions.
      b. In general:
         1) Valve shall be in the fully open position.
         2) Solenoid and expansion valves shall be broken down.

3.3 GROOVED PIPING INSTALLATION

A. Couplings, fittings, valves and pipe shall be assembled in accordance with Manufacturer’s instructions.

B. Support piping according to Manufacturer’s maximum span recommendations or Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment,” whichever is more stringent.

C. Raised face flanges shall have a metal flange washer installed.
D. Cutting, Grooving and Crimping:
  1. All flexible pipe fittings including grooved, cut and plain end and all quick fit fittings shall be installed with a machine specifically designed for this purpose.
  2. All piping to be grooved, cut and crimped shall be prepared using this specifically designed machine.

E. Mechanical joints are not allowed within walls.

3.4 FIELD QUALITY CONTROL

A. Clean and test piping in accordance with Division 22 Section “Testing and Cleaning of Plumbing Systems.”

END OF SECTION 22 05 09
SECTION 22 05 19 – METERS AND GAGES 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. This Section includes the furnishing and installation of all temperature and pressure gages. Unless otherwise specified, gages shall be as described in this Specification.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  1. ASME Standard:
     b. B40.30 - 1990 - Thermometers.

1.4 SUBMITTALS

A. Manufacturer's Literature: For all gages and thermometers. Include name of Manufacturer, model, dimensions, and scale range.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ametek.

B. Ashcroft.

C. H.O. Trerice.

D. 3D Instruments.

E. Trend Instruments.

F. Weiss.

2.2 EQUIPMENT

A. Dial Thermometer:
   1. Direct mounted, bimetal type, universal angle with adjustable dial face.
   2. Stainless steel case, glass lens.
   3. Adjustable joint with finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
   4. 5-inch diameter dial.
   5. 6-inch nominal stem length, stainless steel.
   6. Union lock nut.
10. Accuracy: ± 1% of range span or ± 1 scale division to maximum of 1.5% of range span.
11. Scale Range: Temperature ranges for services listed as follows:
   a. Domestic Hot Water: 30 to 240 degrees F with 2-degree scale divisions.
   b. Domestic Cold Water: 0 to 100 degrees F with 2-degree scale divisions.
12. Equal to H.O. Trerice V80030 Series.

B. Pressure Gage:
   1. General use, ASME B40.1, grade A, phosphor bronze, bottom connection.
   2. Bourdon tube type with direct coupled pointer, liquid filled.
   3. Drawn steel or brass case, glass lens.
   4. Brass connector, 1/4-inch NPS.
   5. Scale: White coated aluminum, with permanently etched markings.
   6. 4-1/2-inch minimum diameter.
   7. Range: 2 times operating pressure.
   8. Accuracy of ± 1% of scale range.
   10. Liquid fill must be compatible with temperatures in measured fluid.

2.3 ACCESSORIES

A. Thermowell:
   1. Provide for all thermometers.
   2. 304 stainless steel.
   3. Pressure rating to match piping system design pressure, with 2-inch extension for insulated piping and
threaded cap nut with chain permanently fastened to well and cap.
   4. Equal to H.O. Trerice Cat. No. 138-0015.3 (138.0016.2 for pipe 6 inches and over).

B. Needle Valve:
   1. Provide for all pressure gages.
   2. Equal to H.O. Trerice Series 735.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all thermometers and pressure gages in conformance with:
   1. The Drawings.
   2. These Specifications.
   3. Manufacturer’s recommendations.

B. Support all pressure gages and remote-reading thermometers:
   1. With 12-gage formed steel bracket.
   2. Secured to structure or equipment.

3.2 APPLICATION

A. Select all dial ranges such that normal operating temperature/pressure measured at point of installation is
   near mid-range, unless otherwise noted.

END OF SECTION 22 05 19
SECTION 22 05 23 – GENERAL DUTY VALVES 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. This Section includes the furnishing and installation of all valves.

1.3 REFERENCES

A. Except as specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by Installer for installation requirements. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
   5. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. General:
   1. This Section is provided as a guide in the application and specification of specific valves intended for use in this Project. This Section does not instruct where to install these valves unless specifically noted. Refer to other specific Plumbing Specification Sections and Drawing details for instruction for location and use.
   2. As indicated on the Drawings.
   3. As called out in the Piping Systems Schedules.

B. Valves not specifically indicated on the Drawings:
   1. Size and class of valve to agree with line in which installed.

C. Valves shall have Manufacturer's name, trademark and working pressure rating cast into the valve body.

1.5 SUBMITTALS

A. Shop Drawings for all valves.

B. Manufacturer's Literature: For All Valves:
   1. Manufacturer’s name.
   2. Details of construction.
   3. Performance characteristics.

1.6 QUALITY ASSURANCE

A. Made in USA:
   1. Unless specifically noted otherwise, all valves shall comply with the Federal Trade Commission Made in USA standard.
   2. Supplier shall furnish documentation of USA content if requested by Engineer.
B. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the material and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Valves shall be manufactured by one Manufacturer for each type of valve. Where valve Manufacturers are not specifically indicated, they shall be one of the following:
   1. Nibco.
   2. Kennedy.
   3. Crane.
   7. Grinnell.
   8. Mueller Steam Specialties
   10. DeZurik.
   11. Hammond.
   12. Apollo.
   13. Watts

2.2 MATERIALS

A. Bronze Valves:
   1. All brass alloys used in valves shall contain no more than 15% zinc.
   2. Alloys must comply with ASTM B61, B62 or B584.

2.3 HAND VALVES

A. General:
   1. Provide extended stem handles with a minimum clearance of 1-1/2-inch on insulated service.
   2. All valves used for throttling/balancing shall have adjustable memory stops.
   3. Pressure ratings are at service indicated by application.

B. Ball Valves: Ball valves used in connection with piping 2 inches in size and smaller shall have screwed or sweat ends, 2 piece bronze body, standard port with stainless steel ball and a like stem. VA rated for 150 pound SWP and 600 WOG. Seats and seals shall be virgin teflon for standard duty cycle. Provide reinforced teflon for applications identified for extended duty cycle.

C. Drain Valves: Furnish at each low point 3/4-inch ball valves as specified above. Install nipple with cap at valve outlet.

D. Plug Valves: Plug valves (gas cock) for natural gas shutoff applications shall be lubricated type equal to Homestead Figure 611 or 612 or Rockwell Figure 114 or 115.

2.4 CHECK VALVES

A. Silent Check Valve:
   1. Install silent check valves in all pump discharge.
   2. Piping less than 2-inch:
      a. High temperature, lead-free not required: 300 pounds, bronze body, renewable bronze disc screwed or sweat ends, bronze trim, Mueller, #103-MBP; or equal.
      b. Lead-free, up to 100°F: Mueller 101MAT or Watts LF600 for applications less than 15 psig.
      c. Lead-free, up to 250°F: Mueller 103MAT and where lead-free is required.
PART 3 - EXECUTION

3.1 VALVE APPLICATION SCHEDULE

A. Cold Water and Hot Water:
   1. Isolation through 2-inch: Ball Valve.
   2. Check: Swing Check through 2-inch, Silent Check for 2 1/2-inch and up.

3.2 INSTALLATION

A. Install valves in conformance with:
   1. The Shop Drawings reviewed by Engineer.
   2. The Manufacturer's recommendations.

B. Install Valves:
   1. At all branch piping connection to mains.
   2. At all connections to equipment.
   3. As required for complete control or isolation of any piece of equipment or service to branch lines.
   4. In accessible locations.
   5. Equal in flow area to connecting piping, unless otherwise indicated.

C. No valve shall be installed with its stem below the horizontal.

D. Install flanged valves at equipment in a manner which allows equipment side of valve to be opened up without draining piping system.

END OF SECTION 22 05 23
SECTION 22 05 29 – 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. This Section includes the furnishing and installation of all pipe hanging and support systems.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:

1. ASME - American Society of Mechanical Engineers:
   a. B31.9 - Building Services Piping.

2. MSS - Manufacturers Standardization Society:
   b. SP-69 - Pipe Hangers and Supports - Selection and Application - 1996.
   c. SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices.
   d. SP-90 - Guidelines on Terminology for Pipe Hangers and Supports.

1.4 DEFINITIONS

A. Pipe Restraint: Pipe supporting element which is designed to limit or direct pipe movement due to internal static pressure, gravitational forces, frictional forces from hangers, rollers, and guides, and forces from expansion compensation devices:
   1. Pipe restraints are not designed to restrain pipe movement caused by thermal expansion, shock or surge.

B. Pipe Guide: A pipe restraint designed to direct pipe movement along a single axis.

C. Pipe Anchor: A pipe restraint designed to provide a static point about which pipe movement normally occurs, by limiting the longitudinal and axial movement at that point.

D. Other Terms: As defined in MSS SP-90.

1.5 DESIGN AND PERFORMANCE REQUIREMENTS

A. Unless otherwise indicated on Drawings or in these Specifications, this Contractor shall be responsible to design and provide all pipe hangers, supports, restraints, braces, framing, etc., as required to comply with all applicable building codes, ASME B31 and MSS SP-69.

B. Comply with the requirements of Division 22 Section “Sound and Vibration Control for Plumbing” for vibration isolation of piping.

C. Comply with the requirements of ASME B31.8 for pipe hangers and support of natural gas piping systems.

1.6 SUBMITTALS

A. Manufacturer's Literature: For structural steel attachment devices, hangers and rollers. Include name of Manufacturer; model number and MSS Type, if applicable; and piping systems to be used with.
B. Submit Shop Drawings for all engineered hanger, restraints and support assemblies.

C. Upon request by Engineer, submit calculations for all engineered hanger, restraints and support assemblies.

1.7 PERFORMANCE REQUIREMENTS

A. Design Responsibilities:
   1. Anchorage of outdoor piping shall be designed by Contractor or their supplier.
   2. Minimum Requirements:
      a. Details, if any, indicated on the Drawings and Specifications contained herein are minimum requirements.
         1) Engineer has designed the structure to withstand the gravity and wind induced loadings of equipment.
         2) Notify Engineer of member size change requirements prior to fabrication.
      b. Generally comply with layouts and configurations as indicated on the Drawings.
   3. Structural Performance:
      a. Design shall be performed by a professional engineer.
      b. Design shall comply with the building code plus amendments and local ordinances, if any, legally adopted for the location in which the Project is located.
      c. Design anchorage systems capable of withstanding design loads within limits and under conditions indicated.
         1) The term "withstand" means that the unit will remain in place without separation of any parts from the device when subjected to the wind forces specified.
      d. Design shall include systems that transfer gravity and wind induced loadings (including lateral, overturning and uplift effects) to the structure, including, but not limited to:
         1) Anchorage between piping and supports.
         2) Anchorage between supports and building structure.
         3) Spacers, blocking, straps and the like.
   4. Design Loads:
      a. Dead Loads: Actual weights of materials and fixed equipment, as calculated by designer.
      b. Wind-Restraint Loading:
         1) Determined by designer in accordance with the basic parameters indicated on the Drawings and procedures indicated in the Building Code.
         2) Design shall not consider shielding by adjacent structures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The materials of all pipe hanging and supporting elements shall be in accordance with the latest requirements of the ASME Code for Pressure Piping B31.1 and MSS Standard Practice MSS SP-58 and MSS SP-69 except as supplemented or modified by the requirements of these Specifications.

B. The material in contact with the pipe shall be compatible with the piping material so that neither shall have a deteriorating action on the other.

C. Special Finishes and Materials: All ferrous hangers and supports used in the following areas shall be hot dip galvanized unless piping or equipment has a field-applied finish.

2.2 MANUFACTURERS

A. Elcon.

B. Michigan Hanger.

C. Anvil.

D. Bergen.
2.3 PIPE HANGERS AND SUPPORTS

A. Horizontal Piping Hangers: Unless otherwise indicated and except as specified in piping system Specification sections, install the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN15 to DN750).
2. Yoke Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 degrees F (49 to 232 degrees C) pipes, NPS 4 to NPS 16 (DN100 to DN400), requiring up to 4 inches (100 mm) of insulation.
3. Carbon or Alloy Steel, Double Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN20 to DN600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN15 to DN600), if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN15 to DN100), 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 noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN15 to DN200).
7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN15 to DN200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN15 to DN200).
9. Adjustable Swivel Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN15 to DN50).
10. Split Pipe Ring With or Without Turnbuckle Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN10 to DN200).
11. Extension Hinged or 2 Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN10 to DN80).
12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30 (DN15 to DN750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

B. Supports and Rollers:

1. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast iron floor flange.
2. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast iron floor flange with U-bolt to retain pipe.
3. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion type support for pipes, NPS 2-1/2 to NPS 36 (DN65 to DN900), if vertical adjustment is required, with steel pipe base stanchion support and cast iron floor flange.
4. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN25 to DN750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.
5. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN65 to DN500), from single rod if horizontal movement caused by expansion and contraction might occur.
6. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN50 to DN1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

7. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN50 to DN600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

8. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN50 to DN750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

C. Vertical Piping Clamps: Unless otherwise indicated and except as specified in piping system specification 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 (DN20 to DN500).
   2. Carbon or Alloy Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500), if longer ends are required for riser clamps.

D. Hanger Rod Attachments: Unless otherwise indicated and except as specified in piping system specification sections, install the following types:
   
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 degree F (49 to 232 degree C) piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type II, 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 degree F (49 to 232 degree C) piping installations.

E. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification sections, install the following types:
   
   1. Restraint Control Devices (MSS Type 47): Where indicated to control piping movement.
   2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
   3. Spring Cushion Roll Hangers (MSS Type 49): For equipping Type 42 roll hanger with springs.
   4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
   5. Variable Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from hanger.
   6. Variable Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from base support.
   7. Variable Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from trapeze support.
   8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load adjustment capability. These supports include the following types:
      a. Horizontal (MSS Type 54): Mounted horizontally.
      b. Vertical (MSS Type 55): Mounted vertically.
      c. Trapeze (MSS Type 56): Two vertical type supports and 1 trapeze member.

2.4 HANGER RODS

A. Minimum rod diameters for rigid rod hangers shall be as shown in MSS SP-69 Table 4 (Minimum Rod Diameter for Single Rigid Rod Hangers) and as indicated in Part 3 of these Specifications.

B. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.

C. Rod material must be compatible with hanger and comply with above. Do not field cut thread on galvanized rod.
D. Do not use perforated strap.

E. Multiple Supports:
   1. Horizontal banks of pipe may be supported on a common base member without regard to the pipe 
      centerline elevation.
   2. In the supporting of multiple pipe runs, provisions shall be made to keep the lines in their relative lateral 
      positions, using clamps or clips as required. Lines subject to thermal expansion shall be free to roll 
      axially or slide.

2.5 SADDLES AND SHIELDS

A. All Piping:
   1. Saddle: MSS Type 39 Anvil Figure 160 to 165.
   2. Shield: MSS Type 40 (Anvil Figure 167), provide and install in accordance with Manufacturer's shield 
      size selection tables.
   3. The contour of the saddle shall match the radius of the pipe insulation.

2.6 ALIGNMENT GUIDES

A. Provide at all expansion loops and joints:
   1. As indicated on the Drawings.
   2. As required to maintain alignment.
   3. In accordance with Expansion Joint Manufacturer's Association recommendations.

2.7 FABRICATED STEEL SUPPORTS AND RESTRAINTS

A. Provide as required:
   1. Steel shapes and plates.
   2. Bolts.
   3. Welds.

B. Materials and fabrication in accordance with:
   2. AISC Code of Standard Practice for Steel Buildings and Bridges (except Section 4.2.1.).

C. Design: Responsibility of Subcontractor.

D. Paint all finished fabrications:
   1. As specified in Division 09 Section "Painting."
   2. Color as directed by Owner.

2.8 MANUFACTURED METAL FRAMING SUPPORT SYSTEMS

A. Acceptable Manufacturers:
   1. Bee Line.
   2. Elcen.
   3. Super Strut, Inc.

B. Provide products from one Manufacturer.

C. Channel (Standard Applications):
   1. Mild strip steel.
   2. 12-gage minimum material.
   3. Factory painted equal to Unistrut Perma-Green.
   4. Equal to Unistrut Part No. P1000.
D. Clamps and Supports:
1. Beam clamp equal to Unistrut Part No. P2785.
2. Pipe strap equal to Unistrut Part No. P2558.
3. Pipe roller equal to Unistrut Part No. P2474.
4. All items fabricated in material equal to channel specifications.
5. Copper pipes supported on metal framing support channels shall be protected from galvanic corrosion by special insulators between the pipe clamp and the channel.

E. Clamp Nuts:
1. Electro-galvanized stainless steel for use with stainless steel and fiberglass parts.
2. Mild bar steel for standard applications.
4. Equal to Unistrut Part No. P1012.

2.9 MANUFACTURED PIPING SUPPORT SYSTEM SUBJECT TO WIND LOADING

A. Support Rails:
1. General Construction:
   a. Material: ASTM A653 G90 hot dipped galvanized steel. Minimum 18 gauge or heavier, as engineered by Manufacturer.
   b. Corners: Mitered and welded (welds are micro sealed and prime painted after fabrication). Bolted connections are not accepted.
   c. Base Plates: Integral to frame and welded.
   d. Internally reinforced with galvanized 1-inch x 1-inch angles for curbs exceeding 3-foot length.
   e. Wood Nailers: Factory installed, decay resistant. Size and width as suitable for support of items installed on rail and perimeter of roof deck.
2. Height: Minimum 12 inches above finished roof surface. Select support so mechanical equipment air inlets are at least 18 inches above the finished roof surface.
3. Constructed to match roof slope with plumb and level top surface for mounting mechanical equipment.
4. Gasketing: Where required, 1/4-inch thick, 1-inch wide under all units.
6. Rail assembly shall be installed under metal roof deck. Perimeter steel roof deck shall be supported by rail assembly. Rail bottom flange shall be a minimum width of 2 inches to support roof deck. Steel clips shall be provided where roof deck flutes do not contact bottom flange of rail, to prevent crushing roof deck.

B. Support Frames
1. General Construction:
   a. Material: Polycarbonate, hot-dipped galvanized steel or stainless steel, as engineered by Manufacturer.
   b. Frame supports are adjustable, utilizing all thread.
   c. Frame bases constructed of non-metallic material compatible with roofing material requirements.
   d. Platforms: Constructed of 18 gage material.

C. Wind Restraints: Metal brackets compatible with the equipment support and equipment casing, galvanized or painted to match equipment unit, used to anchor unit to the support, and designed for loads at Project site.

D. Building Structural Steel Attachment: Provide wind restraint straps, welded strap connectors, and bolted or welded attachment methods to roof structural steel as required to meet wind uplift requirements.

2.10 BUILDING ATTACHMENTS

A. As indicated on the Drawings or in the Specifications.

B. Concrete Attachments:
1. Provide galvanized finish for all attachments used in wet or potentially wet areas.
2. Provide stainless steel bolts and nuts in wet and potentially wet areas.
3. Poured Concrete:
   a. Use cast-in-place inserts or bolted surface mounted attachments, at Contractor's option.
   b. Expansion style anchors are not permitted on piping systems subject to vibration.

4. Precast Concrete Tees:
   a. Use fittings specifically designed for attachment to stems of precast tees.
   b. Drilling is not permitted except where specifically approved by Engineer and coordinated with
   precast Manufacturer to miss embedded, prestressed steel strands.

5. Precast Concrete Plank:
   a. Use toggle bolt attachment as indicated on Drawings.
   b. Alternatively, provide adhesive anchor, Hilti HY-20; or as approved.
   c. Drilling is not permitted except where specifically approved by Engineer and coordinated with
   precast Manufacturer to miss embedded, prestressed steel strands.

C. Horizontal Piping:
   1. Steel W, I, or S shapes: MSS Type 23 clamp with retaining clip, (Anvil Fig. 88, Fig. 89 for non-seismic)
      up to 2-inch; MSS Type 28 (Anvil Fig. 292) or MSS Type 21 (Anvil Fig. 133, 134) above 2-inch.
   2. Steel Channel: MSS Type 20 universal channel clamp.
   3. Bar Joists: Steel washer plate (Anvil Fig. 60).
   4. Concrete: See "B" above.
   5. Timber: Angle bracket and lag screws or as detailed on Drawings.
   6. Steel Z Shapes: Custom attachment required.

D. Vertical Piping:
   1. Steel Shapes: Welded brackets as approved by Engineer.
   2. Concrete: See "B" above.
   3. Timber: Ceiling hanger flange (Anvil Fig. 128R, 153) angle brackets and lag screws, or as detailed on
      Drawings.

E. In the absence of a Specification for a particular type of attachment, furnish attachments comparable in type
   and quality to that specified above for a similar situation.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. General Requirements:
   1. The selection of pipe hangers and supports shall be based on the overall design concept of the piping
      system and any special requirements which may be called for in these Specifications or as indicated on
      the Drawings. The support systems shall provide for, and control, the free or intended movement of the
      piping including its movement in relation to that of the connected equipment. They shall prevent excess
      stress resulting from the transfer of weight being introduced into the pipe or connected equipment.
   2. The selection of hangers and supports shall be made to provide the piping system with the degree of
      control that its operating characteristics require.
   3. The selection of hangers or supports will take into consideration the combined weight of the supported
      systems, including system contents and test water.
   4. Select and install hangers and supports to allow controlled thermal movement of piping system, to
      permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion
      loops, expansion bends and similar units.
   5. The spans in MSS SP-69 Table 3 do not apply where concentrated weights, such as valves or heavy
      fittings, or where changes in direction of the piping occur between hangers.
   6. Select all hangers and supports rated for the maximum potential loading with pipe full.
   7. Select hangers for cold (less than 50 degrees F) piping service for installation over the insulation.
   8. Where significant, vertical movement of pipe occurs at the hanger location a resilient support must be
      used:
      a. Selection of resilient supports shall be based on permissible load variations and effects on
         adjacent equipment. Support selection for typical load variations are shown on MSS SP-69 Table
         2 (Spring Support Selection). Load and movement calculations shall be made for the proper
         selection of spring hangers.
b. Vertical movement and load transfer from riser expansion to horizontal runs shall be given consideration when applying spring hangers.

c. Spring cushion hangers may be used where vertical movement does not exceed 1/4-inch and where formal load and movement calculations are not required.

d. Variable spring hangers shall be used for all other resilient support requirements except as noted in the following paragraph.

e. Constant support hangers shall be used on piping systems where the deviation in supporting force must be limited to 6% and which cannot be accommodated by a variable spring hanger.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification sections.

3.2 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support 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. General:
1. Adjust all components as required for proper operation and required pipe slope.
2. Double nut all support rods at hangers.
3. Location and Routing:
   a. Install Piping as Indicated:
      1) On the Drawings.
      2) On the reviewed Shop Drawings.
   b. Secure Engineer's approval for all pipe routing changes.
4. Coordinate with other trades for placement of concrete attachments prior to concrete pouring.
5. Install all items in accordance with Manufacturer's instructions.

C. Support at Valves: Provide additional supports at all valves in piping 4-inch and larger.

D. Vertical Risers:
1. Support independently from adjacent hangers on horizontal piping.
2. Copper Piping:
   a. Support at the base and at 6-foot maximum centers for sizes 1-1/4-inch and smaller.
   b. Pipes Larger Than 1-1/4-Inch:
      1) Supported at each floor level.
      2) Not to exceed 10-foot centers.
3. Vertical Threaded, Welded or Grooved Steel Piping:
   a. Support at the base of the riser and at every other floor.
   b. Maximum allowable unsupported piping length is 12 feet.
4. Plastic Piping:
   a. Support at 4-foot centers maximum for sizes 1-1/2-inch or smaller.
   b. Support at the base and at 4-foot centers for all sizes larger than 1-1/2 inches.
   c. Completely encircle covering and insulating material.

E. Horizontal Runs:
1. General:
   a. Provide adequate supports for the loads with a factor of safety of at least 5 (400 pounds minimum).
   b. Provide protective shield at all hangers and rollers supporting plastic pipe and coated pipe.
   c. Support spacing not to exceed MSS SP-69 Table 3.
   d. Hanger rod diameter shall not be less than the requirements of MSS SP-69 Table 4.
2. Rollers: All piping systems designed to accommodate thermal expansion movement shall be mounted on rollers.
3. Bar Joists: Attachments to bar joists shall be made to top member and at panel points.

F. Cast Iron Soil Piping:
1. The size of hanger components shall be suitable for the O.D. of the pipe to be supported.
2. Spacing shall comply with MSS SP-69 Table 3.
3.3 PIPE RESTRAINTS

A. Provide adequate pipe restraints for all expansion or contraction of piping due to temperature change:
   1. Including, but not limited to, that indicated on the Drawings.
   2. As instructed by Owner or Engineer.
   3. At locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent transfer of
      loading and stresses to connected equipment.
   4. Spacing: Unless otherwise indicated, install at ends of main pipe runs, at intermediate joints in pipe
      runs between expansion loops and bends.

B. Concrete work installed in connection with anchors or supports: Make with approved Portland Cement:
   1. At least 5-1/2 bags per cubic yard.
   2. Properly mixed with approved aggregate.
   3. Attain a compression strength of not less than 3,000 psi at 28 days.

3.4 VIBRATION ELIMINATORS

A. Provide as indicated on the Drawings and in accordance with the requirements of Division 22 Section “Sound
   and Vibration Control for Plumbing.”

B. Install so as to cause minimum restraint to normal thermal movements.

3.5 INSULATION PROTECTION

A. Provide Protection Saddle:
   1. Equal to insulation thickness.
   2. At each hanger.
   3. For all insulated piping systems where longitudinal expansion exceeds 1-inch per 100 feet.

B. Provide preservative treated wood block "saddle" for all insulated domestic cold water piping systems larger
   than 3-inch IPS. Anvil Fig. 160 to 165is also acceptable.

C. Provide insulation protection shield:
   1. At each hanger for all "cold" (less than 50 degrees F) piping services.
   2. In accordance with the following table:

<table>
<thead>
<tr>
<th>Pipe Size (IPS)</th>
<th>Shield Gage</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>5” and Smaller</td>
<td>16</td>
<td>12”</td>
</tr>
</tbody>
</table>

   3. Installed as follows:
      a. Surround lower covering.
      b. Straddle equidistant on hanger.
      c. Flared at both ends as required to avoid damage to pipe covering, jacket and vapor barrier.

3.6 PAINTING

A. Touchup: Cleaning and touchup of painting of field welds, bolted connections and abraded areas of shop paint
   on miscellaneous metal are specified in Division 09 Section “Painting.”

B. Galvanized Surfaces: Clean welds, bolted connections and abraded areas. Apply galvanizing repair paint to
   comply with ASTM A780.

END OF SECTION 22 05 29
SECTION 22 05 31 – PENETRATIONS 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. This Section includes the furnishing and installation of the major items listed below:
   1. Pipe sleeves.
   2. Prefabricated and site built curb assemblies.
   3. Flashing and sealing of all mechanical openings through weather or waterproofed walls, roofs and floors.
   4. Sealing and finishing of all mechanical openings.
   5. Provide UL rated firestopping and sealing at all new and existing pipe penetrations of fire rated walls.

B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
   1. General Contractor:
      a. Locate and place all sleeved and framed openings as part of constructing the wall and floor surfaces in which the openings occur.
      b. Provide all lintels and required stiffening members for wall and floor openings.
      c. Cut roofing and install flashing for all required openings in proprietary roof membrane systems.
      d. Cut all roof deck openings and provide required framing supports.
   2. Mechanical Subcontractor:
      a. Advise General Contractor of quantity, location and size of all required openings.
      b. Provide all curbs, sleeves, seals, escutcheons and related materials required for finishing, sealing and waterproofing mechanical openings. Furnish all flashing and counterflashing.
      c. Arrange and pay for all openings required after wall, roof and floor construction is complete.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the Work of this Section shall comply with ASTM D2202 - Test Method for Slump of Sealants.

1.4 SUBMITTALS

A. Manufacturer's Literature: For all premanufactured curbs and sealing assemblies.
   1. Manufacturer's name.
   2. Model number.
   3. Details of construction and installation.
   4. Certified load-bearing data for all curbs.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed submittals.

B. Codes and Standards: "Architectural Sheet Metal Manual" as published by SMACNA.

C. Openings in Fire-Rated Surfaces: As specified in Division 07 Section “Penetration Firestopping.”
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Prefabricated Stack Sleeve Assemblies:
   1. Josam.
   2. Wade.
   3. Zurn.

B. Pipe Seals and Boots:
   1. The Pate Company.
   2. Portals Plus, Inc.
   4. Thunderline Corporation.
   5. Thycurb Corporation.

C. Modular Mechanical Seals:
   1. Thunderline/Link-Seal.
   2. As approved.

D. Backer Rod: Industrial Thermo Polymers, "Standard Backer Rod".

E. Acoustical Sealant: Pecora, "BA-98".

F. Expanding Resilient Foam: General Electric, “RTF762.”

2.2 MATERIALS

A. Backer Rod:
   1. Extruded round, closed cell, polyethylene foam.
   2. Resilient, non-exuding.
   3. Density: 2.0 pounds per cubic foot.
   4. Tensile Strength: 50 psi.
   5. Nonabsorbent to water and gasoline.
   6. Suitable for use as a backing for acoustical sealant.
   7. Compatible with sealant and approved by sealant Manufacturer.

B. Acoustical Sealant:
   1. Nonfire-Rated Penetrations:
      a. Non-drying, non-hardening and non-bleeding.
      b. Laboratory tested sealant which effectively reduces airborne sound transmission through wall systems.
      c. Viscosity: 350,000 to 400,000 (Brookfield No. 65, 10 RPM).
      d. Aging: Firm but rubbery, good tack after 50 days conditioned at 160 degrees F.
      e. Slump: 0.1 to 0.2 inches in accordance with ASTM D2202.
      f. Color: Gray.
   2. Fire-Rated Penetrations: Permanently flexible, approved firestop putty. Refer to Division 07 Section “Penetration Firestopping.”

C. Packing Material for Penetrations:
   1. Glass Fiber or Mineral Fiber:
      a. Noncombustible.
      b. Resistant to water, mildew, and vermin.
   2. Expanding Resilient Foams:
      a. Acceptable alternative if manufactured for this purpose.
      b. Minimum material density: 60 pounds per cubic foot.
2.3 SLEEVES

A. Materials:
   1. 18-Gage Galvanized Steel: For pipe penetrations in non-bearing walls.
   2. Schedule 40 Steel Pipe:
      a. For all bearing walls.
      b. For all floors.
   3. Cast Iron Pipe: For all exterior below grade installations.

B. Size All Sleeves:
   1. To allow for movement due to expansion.
   2. To provide for continuous insulation, except as required by Division 07 Section “Penetration
      Firestopping.”
   3. As indicated on the Drawings.

2.4 MANUFACTURED UNITS

A. Stack Sleeves and Flashing Fittings:
   1. Provide as required for roof and floor pipe penetrations.
   2. Equal to Josam 264xx series products.

B. Exterior Pipe Opening Seals:
   1. Compatible with installation conditions.
   2. Equal to One of the Following:
      a. Pate "Pipe Seal".
      b. Portals Plus Model C-126.
   3. Link-Seal.

C. Modular Mechanical Seals:
   1. Provide modular, mechanical type, consisting of inter-locking synthetic rubber links shaped to
      continuously fill the annular space between the pipe and the wall opening.
   2. The elastomeric element shall be sized and selected in accordance with Manufacturer's
      recommendations and have the following properties as designated by ASTM:
      a. For Standard Service Applications:
         1) -40 to +250 degrees F (-40 to +121 degrees C).
         2) EPDM = ASTM D2000 M3 BA510.
      b. For High Temperature or Fire Seal Applications:
         1) -67 to +400 degrees F (-55 to +204 degrees C).
         2) Silicone = ASTM D2000 M1GE505.

PART 3 - EXECUTION

3.1 ROOF OPENINGS

A. Piping:
   1. As indicated on the Drawings.
   2. Fill Annulus Opening:
      a. Use non-combustible insulation material.
      b. Full depth of sleeve.
   3. Provide Moisture Protection Using:
      a. Elastomeric boot.
      b. Metal hood.
      c. Flashing fitting.

B. Locate curbs and sleeves a minimum of 12 inches from walls to permit proper flashing.
3.2 INTERIOR WALL AND FLOOR OPENINGS

A. Flash all floor-mounted drains except in slabs on grade:
   1. Use integral flashing flange and clamp.
   2. As specified in Division 22 Section “Plumbing Pumps.”

B. Use riser sleeve with integral flashing flange and clamp for all waterproof membrane floors.

C. Seal airtight all openings around pipes in the structure at:
   1. Mechanical equipment rooms.
   2. Penetrations of all drywall ceilings and concrete slabs suspended on isolators.
   3. All enclosed shaft penetrations.

D. Pipe Penetrations:
   1. Domestic Water, Sewer, Drain and Vent Piping:
      a. Where a pipe passes through a wall, ceiling, or floor slab, cast or grout a steel sleeve into the
         structure.
      b. Internal diameter of the sleeve: 2 inches (50 mm) larger than the external diameter of the pipe
         passing through it.
      c. After all of the piping is installed in a specific area, check the clearance and correct it, if necessary,
         to within 1/2-inch (12 mm).
      d. Pack the void full depth with packing material and seal at both ends, 1-inch (25 mm) deep.
      e. In noise-critical walls and floors, pack with sealant backed by foam rod.
      f. Where pipes pass through a masonry wall in sufficient numbers and density that individual pack-
         and-calk details are not possible, a special isolation detail shall be developed:
            1) Cast pipe sleeves in a block of concrete with the sleeves located a minimum of 2 inches (50
               mm) apart.
            2) Block thickness: At least as thick as the surrounding wall construction.
            3) Each sleeve diameter: 2 inches (50 mm) larger than the external diameter of the pipe
               passing through it.
            4) Build the sleeved block into the wall.
            5) After the pipes are installed, pack and caulk voids as indicated above.

3.3 FLOOR SLEEVES IN POTENTIALLY WET AREAS

A. All floors except slabs on grade.

B. Extend sleeves 3 inches above finished floor.

C. Provide poured concrete curb for duct openings as indicated in the Drawings.

3.4 ESCUTCHEONS AND CLOSURE COLLARS

A. Includes ceilings, partitions, floor and walls.

B. Provide Escutcheons for All Piping:
   1. Sized to fit over coverings.
   2. In All Potentially Wet Areas: Stainless steel [ in food processing, water and wastewater treatment areas,
      medical procedure room, laboratories and elsewhere as indicated. ]
   3. In All Dry Finished Areas: Chrome plated.
   4. Do not use escutcheons in acoustic isolation walls unless otherwise indicated.

END OF SECTION 22 05 31
SECTION 22 05 73 – TESTING AND CLEANING OF PLUMBING 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 providing testing and cleaning services and the major items listed below:
1. Provide all pumps, gages, valves and other equipment and material necessary to properly conduct tests and perform cleaning.
2. Arrange and pay for all costs of utilities and chemicals required for the Work.
3. Repair and Restore All Work Damaged:
   a. By tests.
   b. By cutting required in connection with the tests.

1.3 SUBMITTALS

A. Flushing and Cleaning:
1. Submit certificates for all code-required inspections.
2. Submit all water Sample analysis reports as required in Part 3 of these Specifications.

B. Pressure Test Reports:
1. Submit within 1 week after each system pressure test.
2. List time, date and persons present for the following for each system:
   a. Initial tests.
   b. Final test.
3. Include report indicating:
   a. Test type and duration.
   b. Initial pressure.
   c. Final pressure.
4. Indicate that necessary repairs and final tests were satisfactorily completed.

1.4 QUALITY ASSURANCE

A. Comply with all applicable codes.

B. Secure State Health Department approval for potable water systems.

C. Testing and Cleaning Agency:
1. Minimum 15 years’ experience in providing cleaning chemicals for water systems use.
2. Provide regional laboratory support services.

PART 2 - PRODUCTS

2.1 CLEANING AGENT MANUFACTURERS

A. Aqua-Chem.
B. Aquatrol.
C. Enerco.
D. Nalco.
2.2 MATERIALS

A. Detergents, solvents and other cleaning agents shall be compatible with materials of fabrication of systems where they are used. No cleaning agent shall adversely affect materials or mechanisms in systems and cleaning agents shall be acceptable to equipment manufacturers and the plant environmental coordinator.

B. Detergents, solvents and other cleaning agents shall be compatible with process streams to be handled by systems in which the cleaning agents are used.

C. Owner will provide water for pipe cleaning and flushing. Other cleaning fluids, agents, and equipment shall be provided by Contractor.

D. Provide the necessary temporary equipment required for cleaning and flushing operations.

E. Provide permanent hose connections for supply, discharge and recirculating lines for the new piping system.

F. Provide piping at the ends of the main and branch lines of the piping system as required to accomplish flush of the piping.

G. Provide a temporary pump of sufficient head and GPM required to achieve a flushing velocity of at least 10 feet per second.

H. Provide temporary chemical skids with tote tanks as required for mixing chemicals and serving as a source reservoir and/or collection point for cleaning and flushing solutions.

I. Provide temporary bag filters (with filter bags) as required for removal of contaminants from flushing process.

J. Provide all hose, electrical leads and supply connections for completion of system required to fill, drain and refill of the lines utilizing plant supplied water and power.

PART 3 - EXECUTION

3.1 PIPING SYSTEM PRESSURE TEST

A. General:
   1. Perform all tests before piping is painted, covered, concealed or backfilled.
   2. Before testing, remove or otherwise protect from damage, control devices, air vents, fixtures, meters, or other parts which are not designated to withstand test pressures.

B. Test Procedures:
   1. Air Test:
      a. Charge with air to the test pressure specified.
      b. When possible, perform test when ambient air temperature is constant.
   2. Soap Test:
      a. Charge with air, water or carbon dioxide to pressure specified.
      b. Examine all joints for leaks with a soap suds solution.
   3. Water Test:
      a. Charge with water to the pressure specified.
      b. Exterior Surface of Pipe and Fittings:
         1) Show no cracks or other form of leaks.
         2) Completely drip dry.
C. Pressure Test Criteria:
   1. Test criteria below are minimum requirements. In addition, the requirements of State and Local Codes having jurisdiction shall be met:

<table>
<thead>
<tr>
<th>Piping System</th>
<th>Type Test</th>
<th>Pressure</th>
<th>Allowable Pressure Drop</th>
<th>Minimum Test Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage System</td>
<td>Water</td>
<td>5 psig</td>
<td>0 psi</td>
<td>30 Minutes</td>
</tr>
<tr>
<td>Vent System</td>
<td>Water</td>
<td>5 psig</td>
<td>0 psi</td>
<td>30 Minutes</td>
</tr>
<tr>
<td>Water (Domestic)</td>
<td>Water</td>
<td>100 psig</td>
<td>0 psi</td>
<td>4 Hours</td>
</tr>
</tbody>
</table>

3.2 FLUSHING AND CLEANING PROCEDURES

A. Preinstallation Cleaning:
   1. Before installation, unless otherwise specified, piping shall be cleaned as follows:
      a. Hammer, brush, scrub with soapy rags, to loosen sand, dirt, or scale when necessary. Remove excess grease and oil from exterior surface.
      b. Blow with air, or flush with clean water, and inspect before erection.
      c. Pipe cleaned and stored before installation shall be dried and ends sealed with a rigid plug or flange protector and tape.
      d. Physical cleaning procedures shall not damage materials or mar surfaces of such materials. Hammering shall not be used on cast iron, fiberglass-reinforced plastic, or plastic pipe.

B. Prior to Flushing:
   1. Remove orifice plates, traps, strainer elements, flow control valves, prior to or during process of cleaning. Remove instruments which might be damaged by cleaning procedures. Replace such items with spool pieces, plugs, or blind flanges. A "blind list" shall be prepared listing where blinds have been installed for cleaning and shall be provided to Owner after cleaning is complete to verify that all blinds have been removed.
   2. Items removed from piping system shall be cleaned separately.
   3. Lock valves in open position.
   4. Use new gaskets, thread lubricants when removed items are reinstalled after cleaning.
   5. Temporary Strainers: Disconnect piping to be flushed from equipment or install temporary strainers immediately upstream of such equipment.

C. System Protection:
   1. Protect piping and equipment against overpressure, collapse from vacuum, and hydraulic shock during flushing and draining procedures.
   2. Exercise special care with polyvinyl chloride (PVC) and fiberglass-reinforced plastic (FRP) piping and upon initial filling of long pipe runs to determine that pipe is in contact with hangers and supports before filling. Piping bowed out of hangers or supports will settle or lengthen during filling and resulting forces may be damaging at changes in direction.
   3. Install high point vents and low point drains required to remove trapped air and to drain flushing liquid.

D. Domestic and Other Open Water Piping Systems: Flush with clean water until all foreign matter is removed.

E. Remove and clean all strainers after flushing is complete.

F. Drain completely and refill after flushing.

3.3 POTABLE WATER PIPING DISINFECTION

A. Disinfect new or repaired potable water systems in accordance with the method prescribed by the local health authority or, in the absence of a prescribed method, in accordance with either AWWA C651 or AWWA C652 or in accordance with the current edition of the International Plumbing Code as described below. This requirement shall apply to "on Site" or "in-plant" fabrication of a system or to a modular portion of a system.
B. Flush the piping system with clean, potable water until dirty water does not appear at any of the points of outlet. Coordinate disposal of all flushing and disinfecting water with the plant environmental coordinator. Install temporary hoses as required to reach existing disposal points, or collect the water in a portable tote tank for transfer to the proper disposal location.

C. Fill the piping with a water/chlorine solution containing at least 50 parts per million (50mg/L) of chlorine, and the piping shall be valved off and allowed to stand for 24 hours; or the piping shall be filled with a water/chlorine solution containing at least 200 parts per million (50mg/L) of chlorine, and allowed to stand for 3 hours; after which the chlorine level shall be tested.

D. Following the required standing time and testing, flush the piping with clean potable water until the chlorine is purged from all parts of the system piping.

E. A bacteria test by an independent agency shall be performed, after the chlorine test has passed. Based on the result from the bacteria test, potable water shall be opened for service. The procedure shall be repeated where shown by a bacteriological examination that contamination remains present in the system.

F. Submit water Sample to State Health Department for test and approval.

END OF SECTION 22 05 73
SECTION 22 07 19 – 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the furnishing and installation of piping insulation.

1.3 REFERENCES:

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:

1. ASTM Specifications:
   b. C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   d. C552 - Cellular Glass Block and Pipe Thermal Insulation.


1.4 SUBMITTALS

A. Manufacturer's Literature: For piping insulation.

1. For Each Type Used:
   a. Name of Manufacturer.
   b. Details of construction and installation.
   c. Manufacturer's data (density, K-factor).

2. For Each Application:
   a. Thickness.
   b. Total "R" value.
   c. Jacket material.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:

1. Trained and experienced in the fabrication and installation of the materials and equipment.

2. Knowledgeable of the design and the reviewed Shop Drawings.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable. Handle and store materials in a manner which will prevent deterioration and contamination with foreign matter.

B. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace removed materials at no additional cost to Owner.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Insulation:
   1. Pittsburgh-Corning.
   2. Owens-Corning.
   3. Certainteed.
   4. Armacell.
   5. Rubatex.

B. Jacketing:
   1. Ceel-Co.
   2. O'Brien.
   5. Pabco.

C. Adhesives:
   1. Benjamin Foster.
   2. Childers.
   3. Vimasco.
   4. B.E.H.
   5. Or equal.

2.2 TYPES OF INSULATION MATERIALS

A. Rigid Molded Glass Fiber – General (FG):
   1. All-service jacket (ASJ) type factory applied jacketing.
   2. 3 lbs/cu ft minimum density.
   3. k factor of 0.23 at 75 degrees F mean.
   4. 50 degree F service temperature.
   5. Owens-Corning Type ASJ Max Pipe Insulation with SSL Max closure system; or equal.
   6. Typical for application on pipes 16 inches and up.

B. Flexible Elastomeric Thermal Pipe Insulation (E):
   1. Density of 5.0 lbs/cubic foot.
   2. k factor of 0.27 at 75 degrees F mean.
   3. Maximum water vapor transmission of 0.17 per inch.
   4. Must be listed for 25/50 flame/smoke spread for thickness used.
   5. Armacell Armaflex AP; or equal.

2.3 PIPE AND FITTING COVERS

A. Polyvinyl Chloride (PVC) Covers:
   1. Ultraviolet resistant.
   2. 0.030-inch minimum thickness.
   3. Preformed to match outer diameter of insulation.
   4. Preformed fitting covers, minimum 10 mil.
   5. Ceel-Tite 330; or equal, by Topline or Zeston.
PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Install piping insulation:
   a. In conformance with the Drawings, these Specifications, and the Manufacturer's recommendations.
   b. After piping system has been satisfactorily tested.
   c. Over clean, dry piping system.
   d. To the following thickness:
      1) As specified herein or as indicated on the Drawings.
      2) If not specified herein or indicated on the Drawings, in accordance with Manufacturer's recommendations for the specific application.
   e. Continuous through walls, ceilings and sleeves except at fire stops.
   f. In areas in pedestrian traffic areas where the bottom of piping is at an elevation less then 6'-8" above finished floor.
2. Fill all cracks and voids with insulating cement carefully troweled to leave a smooth finish.
3. Repair or replace insulation damaged by:
   a. Demolition.
   b. Making connections to piping or equipment.
   c. Water or mildew.
4. Insulate bundles of pipes out-of-doors with complete wrap of insulation 1-1/2 inches thick and of suitable diameter to contain bundle, with outer wrap.

B. Joints and Fittings:
1. Block insulate valves and flanges with reusable insulation system.
2. Insulate elbows, tube turns, sweeps and bends with mitered sections or premolded fittings. Match pipe covering material where used.
3. Fit joints tightly together.
4. Seal joints with sealing compound and preformed aluminum bands.

3.2 JACKETS AND FINISH

A. General:
1. Provide moisture barrier between the insulation and the jacketing in a continuous, unbroken seal.
2. Hold jacketing in place by a continuous sealed joint, providing a positive weatherproof seal along the entire length of the jacket.
3. Cap off ends with caps.
4. On cold lines, cut caps to the exact size of the pipe and seal with a recommended silicone calking.
5. Provide slip joints a minimum of every 25 feet or as needed for expansion.
6. Locate longitudinal jacket seams on indoor exposed piping out of view.

B. PVC:
1. Center a preformed strap (snap-strap) containing a permanently weatherproof plastic sealant over each circumferential joint and secure by tightening on a clip, or by use of a separate stainless steel banding.
2. Design snap-strap to take care of normal expansion.
3. Cover all pipe insulation and preformed insulation fittings.
4. Weld longitudinal seams together with welding adhesive as supplied by cover Manufacturer.
5. Overlap adjacent jacketing 3/4-inch and weld circumferential seams together with welding adhesive.
6. Overlap fitting covers to adjacent pipe insulation jacketing. Weld longitudinal and circumferential seams together with adhesive.

C. Attachment:
1. For systems operating at 50 degrees F and above: May be stapled using outward clinch staples spaced 3 inches apart at least 1/4-inch from the lap edge.
2. For systems operating below 50 degrees F: Vapor seal laps using self-sealing lap, lap seal tape gun or adhesive such as Benjamin Foster 85-60.
D. Taper and seal insulation ends regardless of service.

E. Fitting and pipe jackets to have matching finishes ready for painting.

F. For Insulation Without Factory Applied Jacket:
   1. Finish with 8-ounce glass mesh and mastic.
   2. Use breather mastic on piping operating at temperatures greater than 50 degrees F.

3.3 PIPING INSULATION APPLICATION SCHEDULE

A. Basis of Thickness Chart:
   1. Thicknesses shown are based on products having a maximum "k" factor of 0.26 at a mean temperature of 75 degrees F.
   2. These Thicknesses:
      a. Can be reduced for products having significantly lower "k" values.
      b. Shall be increased for products having higher "k" values in order to produce equivalent or greater thermal resistance.

B. Flame/Smoke Ratings: Local requirements for flame and smoke ratings must be met and may exclude some options listed herein.

C. Jackets and Finish Application: Provide PVC jacket on insulated exposed piping within 7 feet of the floor.

D. Thickness Chart (In Inches):
   1. Key: Insulation Type (Refer to Paragraph 2.2 of this Section):
      a. FG = Rigid Fiberglass.
      b. E = Flexible Elastomeric.

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>Piping Systems Type</th>
<th>Temp (F) Range</th>
<th>Less Than 1&quot;</th>
<th>1&quot; to 1-1/4&quot;</th>
<th>1-1/2&quot; to 3&quot;</th>
<th>4&quot; to 6&quot;</th>
<th>8&quot; &amp; Up</th>
<th>Type of Insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Domestic Hot Water</td>
<td>120-200</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.5</td>
<td>1.5</td>
<td>FG, E</td>
<td></td>
</tr>
<tr>
<td>2. Domestic Cold Water</td>
<td>40-80</td>
<td>0.5</td>
<td>0.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>FG, E</td>
<td></td>
</tr>
<tr>
<td>3. Cooling Coil Drain</td>
<td>--</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>1.0</td>
<td>--</td>
<td>FG, E</td>
<td></td>
</tr>
</tbody>
</table>

* See PART 2 – PRODUCTS Article 2.2 TYPES for types of insulation.

E. Hot Water Heater – WH-1:
   1. Material: Glass fiber board (FG).
   2. Thickness: 2 inches.
   4. Temperature: 500 degrees F.
   5. Finish: Factory applied FSK covered with mastic.

END OF SECTION 22 07 19
SECTION 22 10 00 – PLUMBING PIPING AND 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. This Section includes the furnishing and installation of all materials, labor, equipment, supervision, fees, and services incidental to proper completion of all plumbing system work:
   1. Domestic cold water system.
   2. Domestic hot water system.
   3. Interior waste and vent piping to 5'-0" outside building.
   4. Cooling coil condensate drainage system.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ANSI/ASME Standards:
      b. A112.1.2 - Air Gaps in Plumbing Systems.
      c. A112.21.1 - Floor Drains.
      d. A112.36.2M - Cleanouts.
   2. ASSE (American Society of Sanitary Engineering) Standards:
      a. 1003 - Water Pressure Reducing Valves.
      b. 1016 - Individual Thermostatic Pressure Balancing, and Combination Pressure Balancing and Thermostatic Control Valves for Individual Fixture Fittings.
      c. 1044 - Trap Seal Primer Valves – Drainage Type.
   3. ASTM Standards:
      a. A53 - Steel Pipe, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. A181 - Carbon Steel Forgings for General Purpose Piping.
      d. A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
      e. A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
      f. A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
      g. A395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
      h. A516 - Corrosion-Resistant High Silicon Iron Castings.
      i. B88 - Seamless Copper Water Tube.
      j. B306 - Copper Drainage Tube (DWV).
      k. C76 - Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
      m. D2136 - Test Method for Coated Fabrics - Low Temperature Bend Test.
      n. D2657 - Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
      p. D3034 - Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
      q. D4101 - Polypropylene Plastic Injection and Extrusion Materials.
   4. AWWA Standards:
      a. C500 - Gate Valves for Water and Sewerage Systems.

1.4 SUBMITTALS

A. Manufacturer's Literature: For all products required in Part 2 of this Section:
   1. Required Information:
      a. General:
         1) Name of Manufacturer.
         2) Model number.
         3) Dimensions.
         4) Details of construction and installation.
      b. Performance Data:
         1) Heat transfer devices.
         2) Pumps.
   2. Not required for piping or hangers and supports.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

B. Regulatory Agencies Requirements:
   1. All state and local codes and ordinances shall have jurisdiction.
   2. All related electrical devices shall be housed in suitable enclosures as defined by the National Electrical Manufacturers’ Association (NEMA).
   3. All gas-fired appliances and installation shall be in accordance with American Gas Association (AGA) guidelines.
   4. All components used in systems in contact with drinking water shall comply with the requirements of NSF 372 for lead free.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Comply with the requirements of Division 22 Sections “Cast Iron Pipe and Fittings for Plumbing,” “Plastic Pipe and Fittings for Plumbing,” and “Copper Pipe and Fittings for Plumbing.”

B. Refer to schedules in Part 3 of this Specification for specific applications of pipe materials to plumbing systems.

C. Refer to Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment” and the schedule in Part 3 of this Section for Hanger and Support Requirements for Plumbing System Piping.

2.2 SPECIALTIES

A. Manual Air Vents:
   1. Manufacturer: Bell & Gossett or Dole.
   3. Type: Slotted head (Bell & Gossett 4V or Dole No. 9).
   4. Location: Wherever called for on Drawings.

B. Dielectric Water Fittings:
   1. Dielectric Couplings: Electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.
   2. Dielectric Unions: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered or flanged), which effectively isolates dissimilar metals, prevents galvanic actions and stops corrosion.
2.3 VALVES

A. General Duty Hand Valves: Refer to Division 22 Section “General Duty Valves for Plumbing” for valve construction and material requirements.
   1. Valves Up to 2-inches:
      a. Shut-off: 150 lb bronze gate or full-port ball valve.

B. Mixing Valves
   1. ASSE 1070 Point of Use Thermostatic Control Valve:
      a. Certified for compliance with ASSE 1070 for individual fixture temperature control.
      b. Shall use a wax filled thermostatic element to sense incoming temperature fluctuations and maintain leaving water temperature 3 degrees F of setpoint for flows down to 0.5 gpm.
      c. Construction:
         1) Cast bronze body.
         2) Stainless steel internal components.
         3) 125 psig rated working pressure.
      d. Provide tamper resistant setpoint adjustment.
      e. Provide with integral check valves.
      f. Watts USG-B, Wilkin.

C. Trap Seal Primer Valves:
   1. For applications with frequent flush valve and faucet use, locate near traps:
      a. Install all copper 1/2-inch tube from head of water in the p-trap to floor drain.
      b. Water shall flow by gravity through the pipe under the floor-to-floor drain trap primer connections.
      c. Provide as required in accordance with code and governing authority. Must comply with ASSE 1018.
      d. Manufacturer: Jay R. Smith - Prime-Eze 2699 Water Saver Trap primer; or equal.
   2. For applications with infrequent faucet or flush valve cycles, mount remote from traps:
      a. Provide automatic trap priming system, Precision Plumbing Products (PPP) Model MINI-PRIME for up to 4 floor drains; or equal by MI-FAB.
      b. Provide PPP Model MP-500-115 surface mounted controller.
      c. 115V, including solenoid valve, required distributors, timer, air gap, control panel.
      d. Must comply with ASSE 1044.

2.4 CLEANOUTS

A. Description:
   1. Furnish and install cleanouts where indicated on drawings in accordance with the following table. Wade model numbers are for reference only.
   2. Series floor cleanout with NH spigot outlet or ty-seal outlet connection, threaded adjustable housing, flanged ferrule with tapered brass plug and round or square nickel brass or ductile iron vandal resistant secured top for floor finishes as follows:

<table>
<thead>
<tr>
<th>Location</th>
<th>Wade Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfinished Concrete (Scoriated XH Di Top)</td>
<td>W-6000-Z</td>
</tr>
<tr>
<td>Vinyl Tile (Recessed NB Top)</td>
<td>W-6000-TS</td>
</tr>
<tr>
<td>Ceramic Tile (Scoriated NB Top)</td>
<td>W-6000-XS</td>
</tr>
</tbody>
</table>

B. Manufacturer: Wade, Zurn, Josam, Smith.

2.5 FLOOR DRAINS

A. Furnish and install floor drains at low point of sloped floor or at elevations indicated on the Drawings in accordance with the following.
   1. Provide 4-inch deep seal traps on floor drains.
   2. Provide tapping for connection of trap seal primer line on floor drains.
B. Description:
1. Floor Drains:
   a. FD-1: Wade W-1100-G cast iron floor drain with seepage flange, 5-inch x 5-inch square nickel brass adjustable strainer.

C. Manufacturer: Wade, Josam, Zurn, Smith.

PART 3 - EXECUTION

3.1 DOMESTIC COLD AND HOT WATER SYSTEMS

A. Description: Provide as indicated on the Drawings and as required to comply with all applicable codes and regulations, complete system of piping, fittings, valves, auxiliaries and accessories as required to connect cold and hot water to all items requiring cold or hot water.

B. Pipe and Fittings:
   1. Above Grade: Type L and drawn copper in accordance with ASTM B88 and Division 22 Section “Copper Pipe and Fittings for Plumbing” (maximum pressure of 60 psig). Exposed pipe and fittings at fixtures shall be chrome plated.

C. Installation:
   1. All interior piping shall be run square and straight with the building.
   2. Piping in finished areas shall be concealed within walls, chases, enclosures, etc.
   3. Piping in exposed areas shall be run as high as possible within joists and beam spaces, or below the floor as indicated on the Drawings.
   4. Piping shall follow approved paths as shown or indicated on the Drawings. Connect to existing lines where required or to equipment in an approved manner. Locate pipes, valves and equipment accessible for maintenance, minimum obstruction of passage and work spaces.
   5. Install drain valves at all low points in piping system.
   6. Install all required trap primer systems and piping.
   7. Provide unions at each screwed valve, unions, and at all points in the piping system where necessary to facilitate dismantling.

3.2 BUILDING SANITARY DRAINAGE SYSTEM

A. Description: Furnish and install the entire building sanitary drainage system as indicated on the Drawings. System includes, but is not necessarily limited to, the following items: Waste and vent piping for all plumbing, fixtures requiring same, floor drains, cleanouts.

B. Material:
   1. Above and below ground piping as defined in Part 2 of this Section.
   2. Drains and cleanouts as defined in Part 2 of this Section.

C. Installation:
   1. General runs of sanitary sewer are indicated on Drawings diagrammatically and every bend, offset, etc., is not necessarily indicated, all of which must be installed to properly drain all stacks, fixtures, vents, etc.
   2. Run horizontal waste lines at a minimum slope of 1/4-inch per foot. For lines 4 inches in diameter and above, a minimum slope of 1/8-inch per foot is acceptable.
   3. Connections between mains and laterals shall be made with wyes and 1/8 bends.
   4. Changes in direction shall be with long radius ells except in stacks where sanitary tees and short radius 1/4 bends may be used in changes from horizontal to vertical.
   5. Flash all vent stacks at the roof.
   6. Cleanouts shall be installed where required by code and as indicated on the Drawings and specified herein. They shall be accessibly located, set flush with finish surface or finish grade, and shall be same nominal pipe size as line served, but no larger than 4 inches.
   7. Provide cleanouts located in waterproof above grade floors with flashing flange and clamp device. Flash with 60 mil PVC membrane minimum 4-foot square.
8. Furnish and install stack base fittings at the base of each riser set on a concrete or brick base on firm soil. All vertical risers shall be supported at floors.
9. Pitch vent lines to gravity drain to waste pipe.

3.3 COOLING COIL CONDENSATE DRAINAGE SYSTEM

A. Piping shall be trapped as indicated on Drawings and pitched 1/8-inch per foot minimum.
B. Pipe size to match drain pan connection.
C. Use Schedule 40 PVC piping and provide hangers where necessary as defined in this Section.

3.4 CLEANING, TESTING, CHLORINATION

A. As piping material is erected, the inside of all piping shall be thoroughly cleaned of foreign material. Flush and test piping before operation in accordance with Division 22 Section “Testing and Cleaning of Plumbing Systems.”
B. On completion of the domestic water piping systems, chlorinate the system using methods acceptable to and approved by Engineer. Furnish all chlorine and chlorinating equipment.
C. After system chlorination is complete, submit water Samples to the governing health department for testing. Take Samples as directed by Engineer, and provide Engineer with a letter from the governing health department indicating test results.

3.5 SCHEDULES

<table>
<thead>
<tr>
<th>Storm and Sanitary</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td><strong>Underground</strong></td>
</tr>
<tr>
<td>Sanitary: Minimum size 2 inches</td>
</tr>
<tr>
<td>S.V.</td>
</tr>
<tr>
<td>S.V.</td>
</tr>
<tr>
<td><strong>Above Ground</strong></td>
</tr>
<tr>
<td>Sanitary</td>
</tr>
<tr>
<td>S.V.</td>
</tr>
<tr>
<td>S.V.</td>
</tr>
<tr>
<td>Cooling Coil Condensate</td>
</tr>
<tr>
<td>DWV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Domestic Water Above Ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 PSI Maximum Pressure</td>
</tr>
<tr>
<td>Pipe Size</td>
</tr>
<tr>
<td>1/4 – 6</td>
</tr>
</tbody>
</table>

END OF SECTION 22 10 00
SECTION 22 36 00 – 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the furnishing and installation of a packaged domestic water heater system.

1.3 SYSTEM DESCRIPTION

A. Furnish and install a completely pre-engineered, preassembled, prewired, pretested packaged water heating system of type, size and capacity indicated.

1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. Refer to the Drawings.

1.5 SUBMITTALS

A. Manufacturer’s Literature: For complete assembly.
   1. Manufacturer’s name and model number.
   2. Dimensions.
   3. Details of construction and installation.
   4. Performance data.
   5. Electrical characteristics.

B. Operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. A.G.A. approved and certified.

B. UL listed and approved.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Electric:
   1. A.O. Smith.
   2. Lochinvar.
   3. State.

2.2 DOMESTIC WATER HEATER – ELECTRIC

A. Heaters shall be completely factory assembled and include the following basic features:
   1. Glass-lined tank with magnesium anode and 3-year limited warranty against corrosion.
   2. Steel jacketed with baked enamel finish.
   4. ASME auto-reset type temperature/pressure relief valve.
B. Electric Water Heaters:
   1. Outfitted with sheathed, medium watt density immersion elements, prewired and switched through magnetic contactors.
   2. Include manually resettable high temperature cutoff switch.


PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with Manufacturer’s instructions for the installation of water heaters.

B. Install water heaters with inlet and outlet gate valves, unions, di-electric fittings, relief valves piped full size to floor drains, and temperature gage on outlet water.

C. Construct a level concrete pad foundation according to the Manufacturer’s erecting instructions or as indicated on the Drawings.

D. Factory-authorized service representative shall set and adjust burner and instruct Owner’s representative in care and maintenance of unit.

3.2 VACUUM RELIEF VALVE

A. Furnish and install on cold water supply to water heater when required by authority having jurisdiction or when water heater is mounted higher in elevation than the fixtures it serves.

B. Based on Watts No. N36; or equal.

END OF SECTION 22 36 00
SECTION 22 40 00 – 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 furnishing and installation of plumbing fixtures.

B. Division of Work:
   1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.
   2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
      a. General Contractor: Install or arrange for installation of all fixture supports and carriers as directed by mechanical Subcontractor.
      b. Mechanical Subcontractor:
         1) Furnish all required fixture supports and carriers.
         2) Instruct General Contractor regarding location and installation of supports and carriers.
         3) Be responsible for proper rough-in locations and dimensions.
      c. Faucet Manufacturer: Provides remote transformers for barrier free special trim.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ANSI Standard:
      a. A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
      b. A112.19.2 - Vitreous China Plumbing Fixtures.
      c. A112.19.3 - Stainless Steel Plumbing Fixtures.
      d. A112.19.5 - Trim for Water Closet Bowls, Tanks & Urinals.
   2. ARI - Air Conditioning and Refrigeration Institute - Standard: Drinking Fountains and Self-Contained, Mechanical Refrigerated Drinking Water Coolers.
   3. ADA - Americans with Disabilities Act.
   4. ASSE - American Society of Sanitary Engineers.

1.4 SUBMITTALS

A. Manufacturer's Literature: For fixtures.
   1. Model number/name.
   2. Manufacturer's name.
   3. Dimensions.

1.5 QUALITY ASSURANCE

A. Installing personnel shall be adequately trained and experienced in the installation of the materials and equipment.
B. Regulatory Requirements:
2. Installation shall comply with Americans with Disability Act (ADA) regarding type of fixtures and trim, height and clearance requirements, and safety components and systems.
3. Comply with the State of Michigan barrier free design requirements as published by the Michigan Department of Labor Construction Code Commission.

PART 2 - PRODUCTS

2.1 MANUFACTURER
A. Fixtures: American Standard, Kohler, Elkay, Crane.
B. Flush Valves: Sloan, Zurn, Delaney.
C. ADA Drain and Water Line Safety Covers at Lavatories and Sinks:
   1. Handy shield safety covers, Plumberex Specialty Products, Cathedral City, CA.
   2. Handi Lav-Guard, Truebro, Inc., Ellington, CT.
D. Faucets: Bradley, Moen, Zurn, Chicago Faucets, Delta.
E. Fixture Carriers: Wade, Josam, Zurn, J.R. Smith.

2.2 GENERAL
A. Traps:
   1. Equip fixtures with traps (with cleanouts) unless indicated otherwise, of the same size as the fixture connection.
   2. P-traps (above grade): Cast brass, adjustable, with a cleanout plug and 17 gage tubing outlet, chrome plated. See Division 22 Section "Plumbing Piping and Specialties" for trap primer requirements.
   3. Size branch lines as indicated.
B. Assemblies:
   1. Where fixtures are described by a Manufacturer's assembly number, furnish the complete assembly.
   2. Additional items not ordinarily furnished in the assembly will be indicated or noted.
C. Where roughing-in or installing fixtures and equipment furnished by other trades, provide required stops, supplies and traps, as well as rough-in, installation, and connecting work.
D. Finishes:
   1. Vitreous China Fixtures: White, unless specifically noted otherwise.
   2. Stainless Steel Fixtures: 20 gage minimum, Type 302, nickel bearing stainless steel, unless otherwise noted.
   3. Trim, fittings, traps, etc., where exposed to view: Heavy chrome plated.

2.3 WATER CLOSETS AND LAVATORIES
A. Refer to the schedules on the Drawings for specific applications and the basis of design selections.
B. Fixture Carriers:
   1. Manufacturer: Wade, Zurn Josam, or Smith, Watts.
   2. Requirements:
      a. Secure wall mounted lavatories into position by means of carriers specifically manufactured for the fixture installed.
      b. Carriers shall be of proper size to fit within the space allotted.
   3. Supports: Provide adequate internal supports for wall mounting brackets.
C. Barrier Free Special Trim:
   1. Lavatory faucet activates water flow only when the user’s hands enter infrared detection zone.
   2. Faucet turns itself off after the hands are removed from detection zones.
   3. Incoming water shall be tempered with thermostatic mixing valve.
   4. Tempered water shall not exceed 105 degrees F.
   5. Thermostatic mixing valve and solenoids shall be contained in recessed stainless steel No. 304, 18 gage cabinet, with 16 gage door and key.
   6. Barrier free lavatories shall have water supply tempered with an A.S.S.E. 1017 device.
   7. ADA approved drain and water safety covers are required on all exposed piping under barrier free lavatories.

2.4 SINKS
A. Refer to schedules on the Drawings for specific applications and the basis of design selection.
B. If sink is ADA compliant or used for handwashing, incoming water shall be tempered with approved thermostatic mixing valve.

2.5 MISCELLANEOUS PLUMBING APPLIANCES
A. Refer to the schedules on the Drawings for specific applications and the basis of design selection.
B. Domestic water coolers.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install fixtures at proper heights in accordance with applicable codes and as indicated on the Drawings.
B. Point up around fixtures where they abut a wall or floor unless so directed by Engineer.
C. Securely fasten fixtures to the floor, wall, or counter. Fixtures shall be level and square.
D. Follow Manufacturer’s instructions for fixture installations, especially for grouting and calking.

3.2 INSPECTION
A. Inspect each fixture and unit for damage to finish.
B. Remove and replace cracked, dented units and units or items unable to be repaired or restored to a condition acceptable to Engineer.

3.3 CLEANING
A. Thoroughly clean by washing with soap and disinfectant solution on all plumbing fixtures.
B. Remove, clean, and reinstall aerators.

END OF SECTION 22 40 00
SECTION 23 01 00 – OPERATION AND MAINTENANCE OF HVAC 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.

B. Refer to individual Division 23 sections for additional equipment specific Operations and Maintenance Manual requirements.

1.2 SUMMARY

A. This Section includes preparing and furnishing an operating and maintenance manual for mechanical equipment.

1.3 DESCRIPTION

A. Compile an Operating and Maintenance Manual:
   1. For all building mechanical systems and major equipment items.
   2. Including, but not necessarily limited to:
      a. Installing company's name, address, telephone number and name of job supervisor.
      b. Maintenance and operating booklets (as supplied by the equipment Manufacturer) for each item or representative type item installed.
      c. Valve tag schedule.
      d. A complete set of Shop Drawings.
      e. Temperature control drawings.
      f. Equipment information forms for each equipment piece.
   3. Each equipment information form include all applicable items of the following:
      a. Type of unit.
      b. Manufacturer's name.
      c. Equipment service area.
      d. Recommended cleaning procedures and intervals.

B. Prepare Information Packets:
   1. Attach to each major piece of equipment in a string tie envelope labeled with the equipment's designation in large print.
   2. Information Required:
      a. A copy of the equipment information form as defined above.
      b. A temperature control written operation sequence.
      c. A maintenance checklist form with equipment identification information and listing all relevant maintenance procedures in a column format to accommodate date entries.

1.4 SUBMITTALS

A. Three copies of Operating and Maintenance Manual.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 23 01 00
SECTION 23 05 00 – GENERAL HVAC PROVISIONS

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 specifying the general requirements for execution of that portion of the Work defined in Division 23 of these Specifications and as indicated on the Drawings:

1. Major items include, but are not necessarily limited to:
   a. Cutting and patching.
   b. Concrete foundations and support steel.
   c. Piping, fittings and valves.
   d. Piping, ductwork and equipment insulation.
   e. Temperature and pressure gages.
   f. HVAC equipment, including drives.
   g. Ductwork.
   h. Temperature control systems.
   i. Demolition of existing mechanical work.
   j. Labor, materials, equipment, tools, supervision and start-up services.
   k. Mechanical systems testing, adjusting and balancing.
   l. Instructions to Owner regarding operation.
   m. Incidental and related items necessary to a complete and functionally operational installation of the Work.

B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the Work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the Work:

1. General Contractor:
   a. Install access doors.
   b. Provide concrete isolation and housekeeping pads for mechanical equipment.
   c. Refer to Division 01 Section “Cutting and Patching.” Provide access doors in walls and ceilings for access to mechanical equipment.

2. Mechanical Subcontractor:
   a. Refer to Division 01 Section “Cutting and Patching
   b. Furnish location, size and quantity of openings to Contractor before construction of new walls, ceilings, and floors.
   c. Furnish size and locations of concrete equipment isolation and housekeeping pads as required for this Work and as indicated on the Drawings to Contractor before slabs are poured.
   d. Furnish size and location of access doors required for this work as indicated on the Drawings to Contractor.
   e. Provide miscellaneous structural steel required in connection with support of the Work of Division 23.
   f. Perform final cleaning of mechanical systems and equipment.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of Division 23 shall comply with the following:

2. ASME - American Society of Mechanical Engineers:
   a. B31.1 - Power Piping
   b. B31.9 - Building Services Piping.
1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. Construction details, components, accessories, sizes and model numbers indicated on the Drawings or in these specifications are used to indicate minimum levels of quality and coordination requirements.

B. Equipment supplied, whether as scheduled or selected from list of acceptable Manufacturers, must meet minimum requirements listed in specifications or on Drawings, be compatible with facility and intended use, and meet requirements for a functional system.

C. Drawings:
   1. Are diagrammatic and indicate general arrangement of systems and work included.
   2. Do not necessarily indicate every required valve, fitting, trap, thermometer, gage, duct, elbow, transition, turning vane, mounting support and access panel.
   3. Shall not be scaled for measurement or installation location.
   4. Shall not serve as Shop Drawings.

D. Schedules and model numbers shall not be used to:
   1. Serve as final, definitive quantity requirements. Contractor shall make own count as indicated on Drawings.
   2. Determine proper type or model with arrangement, mounting and accessories applicable.

E. Coordinate installation work of Division 23 with work of other trades to provide a complete and functional system. Generally, the location of ductwork, sanitary, storm and vent piping take precedence over fire protection and HVAC piping, electrical conduit and cable trays.

1.5 PRODUCT UNLOADING AND HANDLING

A. Unload equipment and materials required for completion of the Work.

B. Handle and store equipment and materials carefully to prevent damage. Method of rigging and handling shall be subject to the approval of an authorized representative of the equipment Manufacturer whose equipment is being handled.

1.6 TROUBLESHOOTING

A. By Contractor: If, during the start-up or warranty period, mechanical systems operational problems occur for which the root cause is not readily apparent, Contractor shall promptly, through a Subcontractor or other resource designated by Subcontractor, provide diagnostic and investigative services to determine the cause or causes.

B. By Engineer:
   1. At Contractor’s request, Engineer will provide the services necessary to determine the cause or causes of the operational problems.
   2. Under the provisions of the General Conditions, Engineer will also provide these services if Contractor fails to respond satisfactorily to operational problems within a reasonable time after written notice from Engineer.
   3. If while working at Contractor’s request or under the provisions of the General Conditions, Engineer determines that the problems are due to failure of the Work to comply with the requirements of the Contract Documents, Owner will compensate Engineer for additional services and deduct the amount paid from payment or payments to Contractor.

1.7 MAINTENANCE

A. Special Tools: Where special tools are required for operation, furnish these to Owner.
B. Loose and Detachable Parts:
   1. Retain loose and small detachable parts of the apparatus and equipment furnished until the completion of the Work.
   2. Turn over these parts to Owner.

C. Start-up Filters:
   1. Do not run air handling equipment without filters.
   2. Use of installed permanent heating and cooling equipment ductwork systems shall be in accordance with Division 01 Section “Temporary Facilities and Controls.”
   3. Provide filters as required to protect the air handling systems during construction phase work.
   4. Just prior to Substantial Completion, replace temporary construction filter elements with the owner required filter systems.

D. Construction Strainers:
   1. Remove after flushing and cleaning and prior to commencement of TAB.
   2. Attach removed construction strainer to piping where removed as proof of removal.

PART 2 - PRODUCTS

2.1 FABRICATIONS

A. Miscellaneous Structural Steel:
   1. Structural steel work shall be done in accordance with the AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings, except that allowable stresses shall be reduced 25%.
   2. Where required, high strength structural steel bolting conforming to ASTM Specification A325 and assembled to AISC "Specifications for Assembly of Structural Joints. Using High Strength Steel Bolts" or welding shall be used in place of rivets.
   3. Connections shall be properly designed for the type of connection and the loads to be carried, and shall be subject to Engineer's or Owner's approval.
   4. Welding shall be done by operators who have been previously qualified by tests as prescribed in the American Welding Society "Standard Qualification Procedure" to perform the type of work required.
   6. Finished members shall be true to line and free from twist, bends and open joints.

B. Material installed in a ceiling plenum shall be either noncombustible or have a maximum flame spread of 25 and a maximum smoke developed rating of 50.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Character of Work: Installation shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed.

B. Laying Out of Work:
   1. Layout piping, ductwork, equipment and components in accordance with the Contract Documents and the Manufacturer’s recommended practice, including provision of adequate space for maintenance. Review layout with Engineer prior to installation.
   2. Check drawings of other trades to verify spaces in which work will be installed. Maintain maximum head room and space conditions at all points. Where head room or space conditions appear inadequate, notify Engineer before proceeding with installation.
   3. If directed by Engineer, Contractor shall make reasonable modifications in the layout as required to permit proper execution of the Work and to prevent conflict with work of other trades.
   4. Work shall be installed so as to be ready for operation, maintenance and repair. Minor deviations from Drawings may be made to accomplish this. Changes shall not be made without approval of Engineer.
   5. Unless indicated otherwise, install piping and ductwork concealed above ceilings or within walls.
3.2 MODIFICATIONS TO EXISTING FACILITIES

A. Comply with the requirements of Division 02 Section “Selective Demolition” for removal of existing pipes, equipment, and other systems.

B. Comply with the requirements of Division 02 Section “Selective Demolition,” for all work related to the modification, alteration, conversion, renovation, and reuse of existing facilities.

3.3 PIPE FITTINGS

A. Provide insulating couplings or unions where dissimilar materials are joined.

B. Provide unions at valves and at equipment for making repairs.

3.4 PAINTING

A. Paint exposed, non-insulated piping and exposed ductwork in accordance with the requirements of Division 09 – Finishes.


C. Valves, Fittings, and Supports:
   1. Paint valves and fittings the same base color as the pipe they adjoin.
   2. Paint floor stands the same base color as the pipe they adjoin.
   3. Paint wall brackets and pipe hangers the same base color as the wall or ceiling they adjoin, or gray, if wall or ceiling is not painted.

3.5 CODING AND TAGGING

A. Piping:
   1. Applied to new piping after installation, insulation, and final painting.
   2. Conform to Owner’s existing standards or conventions.
   3. Markings:
      a. Painted on, 1-inch high black letters.
      c. Directional arrow.
   4. Place markers at 20-foot centers with at least 1 in each room.
   5. Plastic coated "Set Mark-Snap-Around" pipe markers manufactured by Seton Name Plate Corp., New Haven, Connecticut; or approved equal, may be used in lieu of painted markers and bands.

B. Valves:
   1. Provide 19-gage brass tags indicating assigned valve number on valves. 1/4-inch high lettering. Tags to be 1-1/2-inch diameter.
   2. Furnish schedule(s) of tagged valves with number, location and purpose of each valve.
   3. Place a copy of each schedule:
      a. In the Maintenance Instructions.
      b. In a string tie envelope labeled "Valve Schedule" and mount in location as designed by the Owner.

C. Where valves, dampers, fans, and terminal units are located above the ceilings, a cadmium plated screw or such marking as designed by Engineer shall be located in the ceiling tile directly below the device.

D. Provide record documentation of all hydronic system air vent locations on record drawings (as-builts) or other method as approved by Engineer.
E. Equipment:
   1. Provide for:
      a. Each Terminal unit, with source air handling unit number.
      b. Labeled with its tag name/number as given on the Drawings.
      c. Use 2-inch high stenciled painted lettering.
   2. Similarly label control components associated with the above named equipment items.
   3. Labels to indicate system and spaces served.

F. Dampers:
   1. Provide for each fire damper, combination fire/smoke damper, smoke damper, and balancing damper.
   2. Label shall bear the tag name and number as indicated on the Drawings.
   3. Use 2-inch high stenciled black lettering.
   4. Mark balancing damper location after final adjustment.

3.6 START-UP

A. Preparation:
   1. Verify That System:
      a. Has been inspected and put in service.
      b. Is fully operational.
   2. Operation and Maintenance Manuals:
      a. Completed.
      b. Sufficient copies available for use in demonstrations and instructions.
   3. Air and hydronic system balancing shall have been completed prior to these performance tests.

B. Demonstration and Instructions:
   1. Demonstration Of and Instruction On Operation and Maintenance of System:
      a. To Owner’s personnel.
      b. Two weeks prior to final inspection.
   2. Equipment Requiring Seasonal Operation: Demonstration within 12 months.
   3. Instruction:
      a. Operation and maintenance manual as basis.
      b. Review contents of manual in detail.
      c. Explain aspects of operation and maintenance.
   4. Demonstrate:
      a. Start-up.
      b. Operation.
      c. Control.
      d. Adjustment.
      e. Troubleshooting.
      f. Servicing.
      g. Maintenance.
      h. Shutdown.

3.7 ADJUSTING

A. Adjust and align equipment for smooth operation:
   1. Plumb true and with parts in proper position and alignment.
   2. Rotating parts shall turn freely and in the correct direction.
   3. Flexible couplings shall be checked for alignment subject to Owner's approval.
   4. Follow Manufacturer's instructions.

B. The work of installation shall be executed in conformity with the best practice, so as to contribute to efficiency of operation, minimum noise or vibration, minimum maintenance, accessibility and sightliness.
3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:
1. Provide when required by individual Section.
2. Provide the following services except where indicated otherwise in individual Sections:
   a. Inspect, check and approve system installation.
   b. Supervise system start-up.
   c. Provide written report indicating that system:
      1) Has been properly installed and lubricated.
      2) Is in accurate alignment.
      3) Is free from undue stress imposed by connecting lines or anchor bolts.
      4) Has been satisfactorily operated under full load conditions.
   d. Demonstrate operation of system to Owner's personnel.
   e. Instruct Owner's personnel on operation and maintenance of system.

B. Performance Test:
1. Test the entire Work, including all of its individual systems for 2 weeks before final payment will be made.
2. Every phase of plumbing, air conditioning and heating and ventilating plant shall be operated separately, or in conjunction one with the other to demonstrate to Engineer the ability of the plant to meet capacity and performance requirements while maintaining design condition, in accordance with the true intent and purpose of these Specifications.
3. Make final tests in the presence of Owner and Engineer.
4. If a part of the Work or equipment does not meet Specifications:
   a. Correct the situation.
   b. Obtain approval of Engineer before final payment is made.
5. Provide the personnel and bear costs for correcting malfunctions.
6. Owner will provide operating personnel and utilities.
7. Air and hydronic systems balancing shall be completed prior to performance testing.

3.9 CLEANING AND FINISHING

A. Comply with the requirements of Division 01 Section “Cleaning and Waste Management.”

B. Entire installation shall be free from surface oil and grease before work will be considered for final payment.

C. After tests have been made and the system pronounced tight:
1. Clean piping and equipment.
2. Lubricate bearings.

D. Final cleaning includes but is not limited to the following:
1. Equipment with Factory Finishes:
   a. Wash factory-finished equipment with mild soap and water and leave in first-class condition, entirely free of stains or streaks.
   b. Do not use abrasive materials. Touch up scratches or other violations of the factory finish paint with matching paint from the equipment Manufacturer prior to cleaning.

END OF SECTION 23 05 00
SECTION 23 05 03 – STEEL PIPE AND FITTINGS 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 the furnishing and installation of steel pipe and fittings.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:

1. ANSI Standards:
   b. B16.4 - Cast-Iron Threaded Fittings, Class 125 and 250.
   c. B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloys and Other Special Alloys.
   e. B16.11 - Forged Steel Fittings, Socket Welding and Threaded.
   f. B16.21 - Nonmetallic Flat Gasket for Pipe Flanges.
   g. B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
   h. B18.2.2 - Square and Hex Nuts.
   i. B31.1 - Power Piping.
   j. B31.9 - Building Services Piping.

2. American Society of Mechanical Engineers (ASME) publications:

3. ASTM Standards:
   a. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   b. A105 - Forgings, Carbon Steel, for Piping Components.
   c. A106 - Seamless Carbon Steel Pipe for High-Temperature Service.
   e. A181 - Forgings, Carbon Steel for General Purpose Piping.
   f. A182 - Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings and Valves for High Temperature Service.
   g. A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   h. A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
   i. A197 - Cupola Malleable Iron.
   j. A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
   l. A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile.
   m. A312 - Seamless and Welded Austenitic Stainless Steel Pipe.

1.4 SUBMITTALS

A. Submit Manufacturer’s Literature: For steel pipe and fittings. Include Manufacturer name, Manufacturer location, dimensions, and details of construction and installation.

B. Manufacturer’s Literature: For couplings and gasketing material.
1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

B. Labeling: Piping materials shall bear the label, stamp or other marking of all specified standards and testing compliance.

C. Testing of Steel Piping: In accordance with Division 23 Section “Testing and Cleaning of HVAC Systems.”

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Except as herein specified or as indicated on the Drawings, all materials shall be in accordance with the Piping Systems Schedule in Part 3 of the appropriate applicable specification section.
   2. Pipe 6'-0" and longer shall be permanently marked with the following information:
      a. Manufacturer's name.
      b. Pressure rating.
      c. Size.
   3. Unless indicated otherwise in application sections of these specifications, all pipe joints shall be welded for pipe sizes 2-1/2 inches and larger.

B. Black Steel Pipe:
   1. Black steel pipe shall be welded or seamless carbon steel, as specified for the type of service.
   2. Welded black steel pipe shall meet the requirements of ASTM A53 or A106, and shall be Type F continuous-weld furnace butt-welding (CW), or Type E electric resistance welded (ERW) Grade B.
   3. Seamless black steel pipe shall meet the requirements of ASTM A53 or A106, Type S seamless, Grade A or B.

2.2 FITTINGS

A. Unions:
   1. Pipe Sizes 2 Inches and Smaller:
      a. Forged steel with ground joint.
      b. Properly fitted for design temperature and pressure.
      c. 2000 pound rated equal to Crane No. 250H or 251H.
   2. Pipe Sizes 2-1/2 Inches and Greater: Use companion flanges where unions are required.

B. Screwed Fittings:
   1. Cast iron in accordance with ANSI B16.4.
   2. Nodular or ductile iron in accordance with ASTM A395.
   3. Forged steel in accordance with ASTM A181.
   4. Schedule 80 fittings shall be used with Schedule 80 pipe.

C. Welding Fittings:
   1. Meet ASTM A 234 symbol WPA or WPB.
   2. The A or B grade shall conform to the grade of pipe used with the fittings.
   3. Dimensional standards shall conform to ANSI B16.9.
   4. Schedule 80 fittings shall be used with Schedule 80 pipe.
D. Flanges:
1. General:
   a. Welding neck or slip-on type with raised face.
   b. Conforming to ANSI B16.5.
   c. Class 150 and 300 conforming to ASTM A181, Grade I.
   d. Class 600 and 900 conforming to ASTM A105, Grade II.
2. Use threaded or socket weld type for piping smaller than 2-1/2 inches.
3. Use flat face steel flanges when matching cast iron companion flanges.

E. Flange Gaskets:
1. Nonasbestos compressed material conforming to ANSI B16.21 and suitable for 600 degrees F service.
2. Ring type, 1/16-inch thickness.
3. Spiral wound stainless steel for service over 300 psi.
4. Use full face gaskets with flat face flanges.

F. Bolting Material:
1. General:
   a. Carbon steel, square-head bolts and Grade 2H hex nuts.
   b. Bolt length shall be sufficient to extend completely through nut with maximum 3/8-inch projection.
   c. Dimensions conforming to ANSI B18.2 (bolts) and ASTM A194 (nuts).
2. Bolts:
   a. For service below 250 psig/450 degrees F, use Grade B conforming to ASTM A307.
   b. For service at or above 250 psig/450 degrees F, use Grade B7 conforming to ASTM A193.

G. Socket Welding Fittings: All forged steel socket-welding fittings shall conform to ANSI Standard B16.11 ASTM A105 Gr. II, equal to Crane 3,000-pound forged fittings.

2.3 GROOVED PIPING SYSTEMS

A. General:
1. Comprised of mechanically cut or roll grooved or crimped pipe and fittings secured with compatible gasketed mechanical couplings.
2. All grooved piping materials shall conform to the specifications governing the systems or application for which they are used.
3. All couplings and fittings shall be finished with hot-dip galvanizing or alkyd enamel paint unless copper.

B. Manufacturers:
1. Victaulic.
2. Or approved equal.

C. Pipe and Tubing:
1. Standard Weight Steel Pipe:
   a. Comply with the requirements of Division 23 Section “Steel Pipe and Fittings for HVAC.”
   b. ASTM Schedule 40, A53 black steel or hot-dipped zinc-coated.

D. Couplings:
1. Housing:
   a. Standard and Light Weight Steel Pipe: Ductile iron, ASTM A536.
   b. Thin Wall Steel Pipe: ASTM A53 black or galvanized steel.
2. Style:
   a. Standard and Light Weight Steel Pipe:
      1) Rigid style.
      2) Victaulic “Zero-Flex” style 07; Grinnell style 772.
   b. Thin Wall Steel Pipe:
      1) Crimp-on style.
      2) Victaulic “Pressfit;” or approved equal.
4. O-rings (Thin Wall Only):
   b. Air and Vacuum Service: Not acceptable.

5. Bolts – Nuts:
   a. Track bolts with 110,000 psi tensile strength.
   b. Heavy hex nuts.
   c. Zinc electroplated carbon steel.

E. Fittings:
   1. Steel, ductile iron or bronze.
   2. Grooves or shoulders compatible with system couplings.
   3. Segmentally welded fittings not acceptable.
   4. Clamp-on mechanical tees not acceptable.

F. Valves:
   1. Refer to Division 23 Section “General Duty Valves for HVAC,” or specification section governing the system or application for which they are used.
   2. Compatible with grooved pipe coupling.

G. Strainers:
   1. Refer to Division 23 Section “Piping Specialties for HVAC.”
   2. Compatible with grooved pipe coupling.

PART 3 - EXECUTION

3.1 PREPARATION

A. During Freezing Weather:
   1. Protect all materials in such a manner that no harm can be done to:
      a. Installations already made.
      b. Materials and equipment on the Site.
   2. Furnish all necessary protection for such installations and equipment as may be required.

3.2 ERECTION

A. General:
   1. All Piping: Follow approved paths as indicated on the Drawings.
   2. Connect to existing lines where required, or to equipment in an approved manner.
   3. Locate Pipes, Valves and Equipment to Provide:
      b. Minimum obstruction of passageways and working space.
   4. Normally, all pipe runs shall be plumb, parallel with the building and level, except for drain slope.
   5. Be responsible for establishing and maintaining drain slope of piping in order to ensure drainage.
   6. Expansion of Piping:
      a. All pipe connections shall provide freedom of movement of the piping during expansion and contraction without springing of piping or injury to building steel or structure.
      b. Any damage to building steel or structure as a result of work installed by Contractor shall be repaired at Contractor's expense.
   7. As Piping Material is Erected:
      a. Thoroughly clean the inside of all piping.
      b. Remove foreign material such as scale, sand, weld spatter, particles and cutting chips.
   8. Provide caps or plugs in all openings at the end of each day's work and as otherwise directed for the protection of the piping. Particular attention must be given to avoid the possibility of any foreign material entering the pipes.
   9. Flanges shall be made on pipe so that the gasket surface forms an angle of 90 degrees with the pipe axis. Screwed flanges shall be made on until the pipe projects through the flanges and then the flanges must be refaced.
B. Sleeves and Holes:
1. Contractor shall be responsible for cutting required holes and openings in floors, walls and other structures, except as noted on the Drawings. Sleeves will be placed by Contractor in all such openings, and no holes shall be cut without Owner's approval. Sleeves shall be in accordance with the standard details included in the Drawings.
2. All holes in floors, walls, roofs, etc., where pipe lines or other materials have been removed or installed, shall be neatly and properly filled with concrete, brick or other material in accordance with the general character of the construction at the location.

C. Unions and Eccentric Fittings:
1. Unions shall be provided at each screwed valve and where their use will facilitate dismantling of the piping and as required or directed in special cases.
2. Eccentric fittings or eccentric reducing couplings shall be provided in all cases where air or water pockets would otherwise occur in the main due to the reduction in pipe size.
3. All reducing fittings used at pump inlets shall be eccentric and flush on the top for hydronic piping.
4. Eccentric fittings shall keep the pipes flush on the bottom for steam and condensate piping.

D. Pipe Joints:
1. Pipe connections at all valves shall be mechanically joined unless otherwise indicated on the Drawings or reviewed by Owner or Engineer.
2. Pipe joints which will be buried or otherwise concealed shall be welded regardless of size.
3. Mitered joints shall not be permitted.
4. In general, black steel 2-1/2-inch and larger shall be welded except that a flange or union shall be provided at all valves and at equipment.
5. The connections to welded 2-1/2-inch and larger pipe shall be made with a welding tee. Field fabricated fittings shall not be permitted.

3.3 WELDING

A. All Pipe Welding:
1. Where welding is called for, it shall be of the fusion process and shall consist of welding by means of either the oxyacetylene or electric arc process.
2. The pipe assembly at orifice and flow nozzle locations shall be left unassembled until inspected and approved by Owner or Engineer.
3. All welding shall conform to the ASME Boiler and Pressure Vessel Code or the ANSI Code for Pressure Piping. All welders shall be qualified in accordance with ASME Standard Qualifications for Welding Procedures, Welders and Welding Operators, or Section 9 of the ASME Boiler and Pressure Vessel Code for the class of piping being welded. Submit welding qualifications for all welders on the Project when requested by Engineer.
4. No welding to building work shall be allowed without approval of Engineer.
5. Black steel piping may be welded with chill rings in lieu of that specified.
6. Mitered turns will not be allowed. Turns shall be made with welded type fittings.

3.4 GROOVED PIPING SYSTEMS

A. Piping shall be prepared in accordance with the latest Manufacturer's specifications or other standards applicable.
B. Light wall (Schedule 30 or lighter) steel piping and copper tubing shall be roll grooved without metal removal.
C. Standard weight (Schedule 40 or heavier) steel piping may be roll grooved or cut grooved.
D. Couplings, fittings, valves and pipe shall be assembled in accordance with latest Manufacturer's instructions.
E. Support piping according to Manufacturer's maximum span recommendations or Division 23 Section "Hangers and Supports for HVAC Piping and Equipment," whichever is more stringent.
F. Raised face flanges shall have a metal flange washer installed.
G. Cutting, Grooving and Crimping:
   1. All flexible pipe fittings including grooved, cut and plain end and all quick fit fittings shall be installed with a machine specifically designed for this purpose.
   2. All piping to be grooved, cut and crimped shall be prepared using this specifically designed machine.

H. Mechanical joints are not allowed within walls.

I. Submit written approval of installation.

3.5 ADJUSTING AND CLEANING

   A. Clean and test piping in accordance with Division 23 Section “Testing and Cleaning of HVAC Systems.”

END OF SECTION 23 05 03
SECTION 23 05 09 – COPPER PIPE AND FITTINGS 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 the furnishing and installation of copper pipe and fittings.

B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
   1. General Contractor: Coordinate work of this Section with other trades.
   2. Mechanical Subcontractor: All work of this Section except as listed under General Contractor.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ASTM Specifications:
      a. B88 - Seamless Copper Water Tube.
      b. B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

1.4 SUBMITTALS

A. Shop Drawings: For couplings, gasketing materials. Include dimensions, details of construction and installation, name of Manufacturer and model.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

B. Testing of Copper Piping: In accordance with Division 23 Section "Testing and Cleaning of HVAC Systems."

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration and contamination with foreign matter.

C. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace removed materials at no additional cost to Owner.
PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Seamless Copper Tubing:
   1. Factory coded and marked.
   2. Conform to the following schedule:
      a. Aboveground: ASTM B88, Type L, hard drawn.
   3. Pipe Markings:
      a. All piping longer than 2'-0" shall have a permanent marking in accordance with ASTM or ANSI
         specifications.
      b. This identification shall include the following:
         1) Manufacturer's name.
         2) Pipe pressure rating.
         3) Pipe size.

B. Solder type shall conform to the following schedule:
   1. Hydronic System Lines: 50% tin, bismuth, 50% lead.
      a. IAPMO listed lead free.
   2. Drain Piping: 50% tin and 50% lead.
   3. Condensate Drain Piping: 50% tin and 50% lead.

C. Fittings: General Service:
   1. Sweat type, wrought copper, long radius elbows.
   2. Cast fittings shall only be allowed with written permission from the Engineer.

2.2 GROOVED PIPING SYSTEMS (Use of Grooved Piping MUST be approved by Wayne State University)

A. General:
   1. Comprised of mechanically cut or roll grooved or crimped pipe and fittings secured with compatible
      gasketed mechanical couplings.
   2. All grooved piping materials shall conform to the specifications governing the systems or application for
      which they are used.
   3. All couplings and fittings shall be copper.

B. Manufacturers:
   1. Victaulic.
   2. Grinnell.

C. Pipe and Tubing: Comply with the requirements above.

D. Couplings:
   1. Housing: Copper Tubing: Ductile iron, ASTM A536.
   2. Style: Copper Tubing:
      a. Rigid style.
      b. Victaulic style 606; Grinnell style 672.
   3. Gasket:
      a. Water Service: EDPM.
      b. Air Surface: Nitrile.
   4. Bolts – Nuts:
      a. Track bolts with 110,000 psi tensile strength.
      b. Heavy hex nuts.
      c. Zinc electroplated carbon steel.

E. Fittings:
   1. Copper or bronze.
   2. Grooves or shoulders compatible with system couplings.
   3. Segmentally welded fittings not acceptable.
   4. Clamp-on mechanical tees not acceptable.
F. Valves:
1. Refer to Division 23 Section “General Duty Valves for HVAC,” or specification section governing the system or application for which they are used.
2. Compatible with grooved pipe coupling.

G. Strainers:
1. Refer to Division 23 Section “Piping Specialties for HVAC.”
2. Compatible with grooved pipe coupling.

PART 3 - EXECUTION

3.1 PREPARATION

A. During Freezing Weather:
1. Protect all materials in such a manner that no harm can be done to:
   a. Installations already made.
   b. Materials and equipment on the Site.
2. Furnish all necessary protection for such installations and equipment as may be required.

3.2 ERECTION

A. General:
1. All Piping: Follow approved paths as indicated on the Drawings.
2. Connect to existing lines where required, or to equipment in an approved manner.
3. Locate Pipes, Valves and Equipment to Provide:
   b. Minimum obstruction of passageways and working space.
4. Normally, all pipe runs shall be plumb, parallel with the building and level, except for drain slope.
5. Be responsible for establishing and maintaining drain slope of piping in order to ensure drainage.
6. Expansion of Piping:
   a. All pipe connections shall provide freedom of movement of the piping during expansion and contraction without springing of piping or injury to building steel or structure.
   b. Any damage to building steel or structure as a result of work installed by Contractor shall be repaired at Contractor's expense.
7. As Piping Material is Erected:
   a. Thoroughly clean the inside of all piping.
   b. Remove foreign material such as scale, sand, weld spatter, particles and cutting chips.
8. Provide caps or plugs in all openings at the end of each day's work and as otherwise directed for the protection of the piping.

B. Pipe Joints:
1. Cut ends of copper tubing squarely using only sharp tube cutters.
2. Ream pipe to full I.D. before preparing the joint.
3. Soldering:
   a. Solder or braze joints by cleaning outside ends of all copper tubings and inside of fittings immediately before joining and soldering.
   b. Apply solder flux to both tube and fitting.
   c. Insert tube full depth into fitting, apply heat and solder in such a manner as to draw solder into and completely around the joint.
4. Joining Valves:
   a. When joining copper lines to valves follow Manufacturer's instructions.
   b. In general:
      1) Valve shall be in the fully open position.
      2) Solenoid and expansion valves shall be broken down.

3.3 GROOVED PIPING SYSTEMS

A. Piping shall be prepared in accordance with the latest Manufacturer’s specifications or other standards applicable.
B. Copper tubing shall be roll grooved without metal removal.

C. Couplings, fittings, valves and pipe shall be assembled in accordance with latest Manufacturer's instructions.

D. Support piping according to Manufacturer’s maximum span recommendations or Division 23 Section “Hangers and Supports for HVAC Piping and Equipment,” whichever is more stringent.

E. Raised face flanges shall have a metal flange washer installed.

F. Cutting, Grooving and Crimping:
   1. All flexible pipe fittings including grooved, cut and plain end and all quick fit fittings shall be installed with a machine specifically designed for this purpose.
   2. All piping to be grooved, cut and crimped shall be prepared using this specifically designed machine.

G. Mechanical joints are not allowed within walls.

H. Submit written approval of installation.

3.4 FIELD QUALITY CONTROL

A. Clean and test piping in accordance with Division 23 Section “Testing and Cleaning of HVAC Systems.”

END OF SECTION 23 05 09
SECTION 23 05 13 – 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 SUMMARY

A. This Section includes the furnishing and installation of all electric motors required for Division 23 specified equipment.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. NEMA - National Electrical Manufacturers Association - Standards and publications governing the following performance criteria:
      a. Frame design.
      b. Torque.
      c. Enclosures.
      d. Dimensions.
      e. Power supply and voltages.
      f. Locked rotor KVA per horsepower.
      g. Service factor.
      h. Sound power levels.
   2. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

A. Manufacturer’s Literature:
   1. All polyphase motors.
   2. All motors 3 horsepower (name plate) and larger.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacture of electric motors and their accessories, with minimum 3 years documented product development, testing, and manufacturing experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored onsite from weather and moisture by maintaining factory covers and suitable weatherproof covering.

B. For extended outdoor storage, remove motors from equipment and store separately in a protected area.

1.7 WARRANTY

A. Provide 2 year Manufacturer’s warranty.

B. Provide with bearing warranty for lifetime of motor.
PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Reliance.
B. Magnetek.
C. Baldor.
D. Lincoln Electric.
E. Subject to compliance with specifications, motors drawing less than 250 watts and intended for intermittent service may be supplied by an alternate Manufacturer commonly used by the equipment Manufacturer.

2.2 SPEED (EXCEPT WHERE NOTED OTHERWISE)

A. 1,800 rpm.
B. Constant speed.

2.3 CONSTRUCTION

A. Designed for continuous operation in 40 degree C environment, Class B insulation. Motors interconnected with a variable frequency drive shall be provided with Class F insulation and shall be inverter duty rated, and shall be outfitted with bearing protection ring.
   1. Bearing protection ring shall be Type SGR as manufactured by Aegis; or approved equal.
B. All copper windings with a minimum service factor of 1.15 for totally enclosed, fan-cooled (TEFC) and 1.25 for open, drip-proof (ODP) motors.
C. NEMA frame, arrangement, and design as required for the specific application.
D. Permanently lubricated unless specifically noted otherwise.
E. Comply with all requirements for UL approval and labeling for specific hazard classification where explosion-proof and severe duty motors are indicated.
F. Provide a visible stainless steel nameplate indicating:
   1. Motor horsepower.
   2. Voltage.
   3. Phase.
   5. RPM.
   6. Full load amps.
   7. Locked rotor amps.
   8. Frame size.
   9. Manufacturer's name and model number.
   10. Service factor.
   12. Efficiency: Nameplate motor efficiency shall be identified in accordance with NEMA MG-1-12.54.2.
G. Except as specifically noted, all motors shall be high efficiency as listed in NEMA Standard 12.6 for all motors 1 horsepower and larger: All efficiency ratings are to be as tested in accordance with IEEE Spec. 112, Method B.
H. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.

I. Variable frequency drive units and motors shall be matched for proper operating characteristics.

2.4 VOLTAGE AND MOTOR TYPE

A. Special conditions and voltage are noted on the Drawings.

B. 3-Phase Power - Squirrel Cage Motors:
   1. Starting Torque: One to one and one-half times full load torque.
   2. Starting Current: Six times full load current.
   3. Power output, locked rotor torque, breakdown or pullout torque: NEMA Design B characteristics.
   5. Insulation System: NEMA Class B or better.
   6. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
   7. Bearings:
      a. Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours.
      b. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension.
      c. Stamp bearing sizes on nameplate.
   8. Sound Power Levels: To ANSI/NEMA MG 1, 75 dBA SPL at 3 feet maximum.
   9. Nominal Power Factor: Meet or exceed values in Schedules at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

2.5 RATINGS

A. Motors shall meet NEMA standards and be capable of operating at rated load with a voltage variation of ±10%, a variable of ±5% in rated frequency, or a combined variation of 10% without damage to the motor.

B. Motors shall be selected for the type of service involved and shall be selected at a minimum of 15% above the required rating of the equipment served. (Does not include service factor.)

2.6 THERMAL OVERLOADS

A. Provide built-in thermal overloads on all fractional horsepower motors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All materials and equipment shall be installed in accordance with Manufacturer's recommended installation methods for obtaining conformance with the Contract Documents.

B. Alignment of all motors, factory coupled or mounted, and all motors field coupled and mounted, shall be rechecked after all connections have been made and after 48 hours of operation in designed service.

C. Verify the voltage characteristics of each motor prior to ordering.

D. Verify the correct wire connections and rotation of equipment by "bumping" motor after wiring.

E. Confirm voltage imbalance on 3-phase motors is less than 2%. 
3.2 APPLICATION: Except as specifically indicated, motors shall be selected as follows:

A. Shaded pole motors are not acceptable.

B. Phase, except where noted otherwise:
   1. 1/2 HP and Less: Single-phase, direct drive.
   2. Larger than 1/2 HP: Three-phase, direct drive.

C. Enclosure: Totally enclosed fan-cooled (TEFC) for all motors located outside.

END OF SECTION 23 05 13
SECTION 23 05 23 – GENERAL DUTY VALVES 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 the furnishing and installation of all valves.

1.3 REFERENCES

A. Except as specified or as indicated on the Drawings, the work of this Section shall comply with the following:

1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by Installer for installation requirements. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.


5. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).


1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. General:

1. This Section is provided as a guide in the application and specification of specific valves intended for use in this Project. This Section does not instruct where to install these valves unless specifically noted. Refer to other specific Mechanical Specification Sections and Drawing details for instruction for location and use.

2. As indicated on the Drawings.

3. As called out in the Piping Systems Schedules.

B. Valves not specifically indicated on the Drawings:

1. Size and class of valve and pipe schedule to agree with line in which installed.

C. Valves shall have Manufacturer's name, trademark and working pressure rating cast into the valve body.

1.5 SUBMITTALS

A. Shop Drawings for all valves.

B. Manufacturer's Literature: For All Valves:

1. Manufacturer's name.

2. Details of construction.

3. Performance characteristics.

4. Pressure and temperature ratings.

5. Close-off pressure.
1.6 QUALITY ASSURANCE

A. Made in USA:
   1. Unless specifically noted otherwise, all valves shall comply with the Federal Trade Commission Made in USA standard.
   2. Supplier shall furnish documentation of USA content if requested by Engineer.

B. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the material and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Valves shall be manufactured by one Manufacturer for each type of valve. Where valve Manufacturers are not specifically indicated, they shall be one of the following:
   1. Nibco.
   2. Kennedy.
   4. Stockham.

B. Acceptable Manufacturers of valves, hose kits and hook-ups:
   1. Nexus.
   2. Armstrong.
   3. B&G.

2.2 MATERIALS

A. Bronze Valves:
   1. All brass alloys used in valves shall contain no more than 15% zinc.
   2. Alloys must comply with ASTM B61, B62 or B584.

2.3 HAND VALVES

A. General:
   1. Provide extended stem handles and necks with a minimum clearance of 1-1/2-inch on insulated service.
   2. All valves used for throttling/balancing shall have adjustable memory stops.
   3. Pressure ratings are at service indicated by application.

B. Globe Valves:
   1. Threaded end 2-inch and smaller (125 psig and less): 125 pounds wsp, bronze body, rising stem, screwed bonnet, Teflon disc, Grinnell No. 3210, Crane No. 7.
   2. Threaded end 2-inch and smaller (above 125 psig): 300 pounds wsp, bronze body, rising stem, union bonnet, renewable Teflon disc, Grinnell No. 3251, Crane No. 362-E.
   3. Solder joint end 2-inch and smaller: 125 pounds wsp, bronze body, rising stem, screwed bonnet, Teflon disc, Grinnell No. 3210SJ, Crane No. 1310.

C. Ball Valves:
   1. Ball valves used in connection with piping 2 inches in size and smaller shall have screwed or sweat ends, 2 piece bronze body, standard port with stainless steel ball or cadd plated ball and a like stem. VA rated for 150 pound SWP and 600 WOG. Seats and seals shall be virgin teflon for standard duty cycle. Provide reinforced teflon for applications identified for extended duty cycle.
   2. 3 inches and larger shall be flanged or butt welded.

D. Drain Valves: Furnish at each low point 3/4-inch gate or ball valves as specified above. Install nipple with cap at valve outlet.
E. Plug Valves:
   1. Plug valves shall be nonlubricated eccentric plug type rated for 175 pound WOG with semi-steel body neoprene coated plug and epoxy coated seat; equal to DeZurik Series 100 or Homestead Ballcentric. Furnish with compatible wrench. All valves used for throttling/balancing to have adjustable memory stop.
   2. Plug valves (gas cock) for natural gas shutoff applications shall be lubricated type equal to Homestead Figure 611 or 612 or Rockwell Figure 114 or 115.

2.4 CHECK VALVES

A. Silent Check Valve:
   1. Install silent check valves in all pump discharge.
   2. Piping less than 2-inch: 300 pounds, bronze body, renewable bronze disc screwed or sweat ends, bronze trim, Mueller, #203 BP; or equal.

B. Swing Check Valve:
   1. 2-Inch and Smaller: 150 psi valves for heating hot water.
      a. MSS SP-80; Class 125, cast-bronze body and cap conforming to ASTM B62; with horizontal swing, Y-pattern, and bronze disc; and having threaded or solder ends.
      b. Provide valves capable of being reground while the valve remains in the line.
      c. Provide Class 150 valves meeting the above specifications, with threaded end connections, where system pressure requires or where Class 125 valves are not available.

2.5 AUTOMATIC CONTROL VALVES - MODULATING SERVICE

A. Manufacturers:
   1. Fisher.
   2. Leslie.
   3. Siemens.
   4. Honeywell.

B. Hydronic Control Valves:
   1. Provide globe type or characterized port ball valve, modulating device with equal percentage relationship between valve lift and fluid flow unless noted otherwise.
   2. Body:
      a. Flanged cast iron for sizes 2-1/2 inches and larger.
      b. Screwed bronze for sizes 2 inches and smaller.
   3. Trim:
      a. Stainless steel stem.
      b. Brass plug with renewable composition disc.
      c. Replaceable seat.

C. Sizing: 3 psi maximum pressure drop at design flow where Cv is not indicated for hydronic applications.

D. Operating Pressure: Provide valve and operator designed for tight shutoff at 125% of design pressure:

E. Operators:
   1. Electric:
      a. Serviceable and rebuildable.
      b. Alternate Manufacturers:
         1) Belimo.
         2) Honeywell.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valves in conformance with:
   1. The Shop Drawings reviewed by Engineer.
   2. The Manufacturer's recommendations.

B. Install Valves:
   1. At all branch piping connection to mains.
   2. At all connections to equipment.
   3. As required for complete control or isolation of any piece of equipment or service to branch lines.
   4. In accessible locations.
   5. Equal in flow area to connecting piping, unless otherwise indicated.

C. No valve shall be installed with its stem below the horizontal.

D. Furnish chain operated hand wheels, including rust-proof chain and chain guide for inaccessible overhead valves.

E. Install flanged valves at equipment in a manner which allows equipment side of valve to be opened up without draining piping system.

END OF SECTION 23 05 23
SECTION 23 05 29 – 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the furnishing and installation of all pipe hanging and support systems.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ASME - American Society of Mechanical Engineers:
      c. B31.9 – Building Services Piping.
   2. MSS - Manufacturers Standardization Society:
      b. SP-69 - Pipe Hangers and Supports - Selection and Application - 1996.
      c. SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices.
      d. SP-90 - Guidelines on Terminology for Pipe Hangers and Supports.

1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. Unless otherwise indicated on Drawings or in these Specifications, this Contractor shall be responsible to design and provide all pipe hangers, supports, restraints, braces, framing, etc., as required to comply with all applicable building codes, ASME B31 and MSS SP-69.

B. Comply with the requirements of Division 23 Section “Sound and Vibration Control for HVAC” for vibration isolation of piping.

C. Comply with the requirements of ASME B31.8 for pipe hangers and support of natural gas piping systems.

D. The Work in this Section includes responsibility for all hangers, supports, restraints, braces, framing, etc. as required to comply with the requirements of the International Building Code of 2006.

1.5 SUBMITTALS

A. Manufacturer's Literature: For structural steel attachment devices, hangers and rollers. Include name of Manufacturer, model number and MSS Type, if applicable; and piping systems to be used with.

B. Submit Shop Drawings for all engineered hanger, restraints and support assemblies.
   1. For Metal Framing Pipe Supports: Include locations, dimensions, lengths, Manufacturer, material, cross-section number or type, finish, pipe sizes, and pipe locations.

C. Upon request by Engineer, submit calculations for all engineered hanger, restraints and support assemblies.
   1. Calculations: For metal framing pipe supports upon request by Engineer. Include support locations, pipe sizes, pipe weights, allowable stresses, and actual stresses.
PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The materials of all pipe hanging and supporting elements shall be in accordance with the latest requirements of the ASME Code for Pressure Piping B31.1 and MSS Standard Practice MSS SP-58 and MSS SP-69 except as supplemented or modified by the requirements of these Specifications.

B. The material in contact with the pipe shall be compatible with the piping material so that neither shall have a deteriorating action on the other.

C. Special Finishes and Materials: All ferrous hangers and supports used in the following areas shall be hot dip galvanized unless piping or equipment has factory has a field-applied finish.

2.2 MANUFACTURERS

A. Elcon.

B. Michigan Hanger.

C. Anvil.

D. Bergen.

E. Hilti.

F. Lindapter.

2.3 PIPE HANGERS AND SUPPORTS

A. Horizontal Piping Hangers: Unless otherwise indicated and except as specified in piping system Specification sections, install the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN15 to DN750).

2. Yoke Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 degrees F (49 to 232 degrees C) pipes, NPS 4 to NPS 16 (DN100 to DN400), requiring up to 4 inches (100 mm) of insulation.

3. Carbon or Alloy Steel, Double Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN20 to DN600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN15 to DN600), if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN15 to DN100), 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 noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN20 to DN200).

7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN200).

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN15 to DN200).

9. Adjustable Swivel Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN15 to DN50).

10. Split Pipe Ring With or Without Turnbuckle Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN10 to DN200).

11. Extension Hinged or 2 Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN10 to DN80).

12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30 (DN15 to DN750).

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
B. Supports and Rollers:
1. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast iron floor flange.
2. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast iron floor flange with U-bolt to retain pipe.
3. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion type support for pipes, NPS 2-1/2 to NPS 36 (DN65 to DN900), if vertical adjustment is required, with steel pipe base stanchion support and cast iron floor flange.
4. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN25 to DN750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.
5. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN65 to DN500), from single rod if horizontal movement caused by expansion and contraction might occur.
6. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN50 to DN1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
7. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN50 to DN600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
8. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN50 to DN750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

C. Vertical Piping Clamps: Unless otherwise indicated and except as specified in piping system specification 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 (DN20 to DN500).
2. Carbon or Alloy Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500), if longer ends are required for riser clamps.

D. Hanger Rod Attachments: Unless otherwise indicated and except as specified in piping system specification sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 degree F (49 to 232 degree C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type II, 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 degree F (49 to 232 degree C) piping installations.

E. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification sections, install the following types:
1. Restraint Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring Cushion Roll Hangers (MSS Type 49): For equipping Type 42 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from hanger.
6. Variable Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from base support.
7. Variable Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load adjustment capability. These supports include the following types:
a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical type supports and 1 trapeze member.
2.4 HANGER RODS

A. Minimum rod diameters for rigid rod hangers shall be as shown in MSS SP-69 Table 4 (Minimum Rod Diameter for Single Rigid Rod Hangers) and as indicated in Part 3 of these Specifications.

B. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.

C. Rod material must be compatible with hanger and comply with above. Do not field cut thread on galvanized rod.

D. Do not use perforated strap.

E. Multiple Supports:
   1. Horizontal banks of pipe may be supported on a common base member without regard to the pipe centerline elevation.
   2. In the supporting of multiple pipe runs, provisions shall be made to keep the lines in their relative lateral positions, using clamps or clips as required. Lines subject to thermal expansion shall be free to roll axially or slide.

2.5 SADDLES AND SHIELDS

A. All Piping:
   1. Saddle: MSS Type 39 (Grinnell #160-164), or Anvil Figure 162 or 165.
   2. Shield: MSS Type 40 (Grinnell #167), provide and install in accordance with Manufacturer's shield size selection tables.
   3. The contour of the saddle shall match the radius of the pipe insulation.

2.6 FABRICATED STEEL SUPPORTS AND RESTRAINTS

A. Provide as required:
   1. Steel shapes and plates.
   2. Bolts.
   3. Welds.

B. Materials and fabrication in accordance with:
   2. AISC Code of Standard Practice for Steel Buildings and Bridges (except Section 4.2.1.).

C. Design: Responsibility of Subcontractor, except as specifically indicated on Drawings.

D. Paint all finished fabrications:
   1. As specified in Division 09 - Finishes.
   2. Color as directed by Engineer.

2.7 MANUFACTURED PIPE SUPPORT SYSTEM

A. Acceptable Manufacturers:
   1. B-Line.
   2. Elcen.
   3. Super Strut, Inc.

B. Provide products from one Manufacturer.
C. Channel (Standard Applications):
   1. Mild strip steel.
   2. 12 gage minimum material.
   3. Factory painted equal to Unistrut Perma-Green.
   4. Equal to Unistrut Part No. P1000.

D. Clamps and Supports:
   1. Beam clamp equal to Unistrut Part No. P2785.
   2. Pipe strap equal to Unistrut Part No. P2558.
   3. Pipe roller equal to Unistrut Part No. P2474.
   4. All items fabricated in material equal to channel specifications.

E. Clamp Nuts:
   1. Electro-galvanized stainless steel for use with stainless steel and fiberglass parts.
   2. Mild bar steel for standard applications.
   4. Equal to Unistrut Part No. P1012.

2.8 BUILDING ATTACHMENTS

A. As indicated on the Drawings or in the Specifications.

B. Concrete Attachments:
   1. Provide galvanized finish for all attachments used in wet or potentially wet areas.
   2. Provide stainless steel bolts and nuts in wet and potentially wet areas.
   3. Poured Concrete:
      a. Use cast-in-place inserts or bolted surface mounted attachments, at Contractor's option.
      b. Expansion style anchors are not permitted on piping systems subject to vibration.
   4. Precast Concrete Tees:
      a. Use fittings specifically designed for attachment to stems of precast tees.
      b. Drilling is not permitted except where specifically approved by Engineer and coordinated with precast Manufacturer to miss embedded, prestressed steel strands.
   5. Precast Concrete Plank:
      a. Use toggle bolt attachment as indicated on Drawings.
      b. Alternatively, provide adhesive anchor, Hilti HY-20; or as approved.
      c. Drilling is not permitted except where specifically approved by Engineer and coordinated with precast Manufacturer to miss embedded, prestressed steel strands.

C. Horizontal Piping:
   1. Steel W, I, or S shapes: MSS Type 23 clamp with retaining clip, (Grinnell Fig. 87) up to 2-inch; MSS Type 28 (Grinnell Fig. 292) or MSS Type 21 (Grinnell Fig. 133, 134) above 2-inch.
   2. Steel Channel: MSS Type 20 universal channel clamp.
   3. Bar Joists: Steel washer plate (Grinnell Fig. 60).
   4. Concrete: See "B" above.
   5. Timber: Angle bracket and lag screws or as detailed on Drawings.
   6. Steel Z Shapes: Custom attachment required. Submit details of welded or bolted attachment to Engineer.

D. In the absence of a Specification for a particular type of attachment, furnish attachments comparable in type and quality to that specified above for a similar situation.
PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. General Requirements:
   1. The selection of pipe hangers and supports shall be based on the overall design concept of the piping system and any special requirements which may be called for in these Specifications or as indicated on the Drawings. The support systems shall provide for, and control, the free or intended movement of the piping including its movement in relation to that of the connected equipment. They shall prevent excess stress resulting from the transfer of weight being introduced into the pipe or connected equipment.
   2. The selection of hangers and supports shall be made to provide the piping system with the degree of control that its operating characteristics require.
   3. The selection of hangers or supports will take into consideration the combined weight of the supported systems, including system contents and test water.
   4. Select and install hangers and supports to allow controlled thermal movement of piping system, to permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends and similar units.
   5. The spans in MSS SP-69 Table 3 do not apply where concentrated weights, such as valves or heavy fittings, or where changes in direction of the piping occur between hangers.
   6. Select all hangers and supports rated for the maximum potential loading with pipe full.
   7. Select hangers for cold (less than 50 degrees F) piping service for installation over the insulation.
   8. Where significant, vertical movement of pipe occurs at the hanger location a resilient support shall be used:
      a. Selection of resilient supports shall be based on permissible load variations and effects on adjacent equipment. Support selection for typical load variations are shown on MSS SP-69 Table 2 (Spring Support Selection). Load and movement calculations shall be made for the proper selection of spring hangers.
      b. Vertical movement and load transfer from riser expansion to horizontal runs shall be given consideration when applying spring hangers.
      c. Spring cushion hangers may be used where vertical movement does not exceed 1/4-inch and where formal load and movement calculations are not required.
      d. Variable spring hangers shall be used for all other resilient support requirements except as noted in the following paragraph.
      e. Constant support hangers shall be used on piping systems where the deviation in supporting force must be limited to 6% and which cannot be accommodated by a variable spring hanger.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification sections.

3.2 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support 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. General:
   1. Adjust all components as required for proper operation and required pipe slope.
   2. Double nut all support rods at hangers.
   3. Location and Routing:
      a. Install Piping as Indicated:
         1) On the Drawings.
         2) On the reviewed Shop Drawings.
      b. Secure Engineer's approval for all pipe routing changes.
   4. Coordinate with other trades for placement of concrete attachments prior to concrete pouring.
   5. Install all items in accordance with Manufacturer's instructions.

C. Support at Valves: Provide additional supports at all valves in piping 4-inch and larger.
D. Horizontal Runs:
1. General:
   a. Provide adequate supports for the loads with a factor of safety of at least 5 (400 pounds minimum).
   b. Provide protective shield at all hangers and rollers supporting plastic pipe and coated pipe.
   c. Support spacing not to exceed MSS SP-69 Table 3.
   d. Hanger rod diameter shall not be less than the requirements of MSS SP-69 Table 4.
2. Rollers: All piping systems designed to accommodate thermal expansion movement shall be mounted on rollers.
3. Bar Joists: Attachments to bar joists shall be made to top member and at panel points.

3.3 PIPE RESTRAINTS

A. Concrete work installed in connection with anchors or supports: Make with approved Portland Cement:
   1. At least 5-1/2 bags per cubic yard.
   2. Properly mixed with approved aggregate.
   3. Attain a compression strength of not less than 3,000 psi at 28 days.

3.4 VIBRATION ELIMINATORS

A. Provide as indicated on the Drawings and in accordance with the requirements of Division 23 Section “Sound and Vibration Control for HVAC.”

B. Install so as to cause minimum restraint to normal thermal movements.

3.5 INSULATION PROTECTION

A. Provide Protection Saddle:
   1. Equal to insulation thickness.
   2. At each hanger.
   3. For all insulated piping systems where longitudinal expansion exceeds 1-inch per 100 feet.
   4. Installed as follows:
      a. Surround lower covering.
      b. Straddle equidistant on hanger.
      c. Flared at both ends as required to avoid damage to pipe covering, jacket and vapor barrier.

3.6 PAINTING

A. Touchup: Cleaning and touchup of painting of field welds, bolted connections and abraded areas of shop paint on miscellaneous metal are specified in Division 09 – Finishes for Painting.

B. Galvanized Surfaces: Clean welds, bolted connections and abraded areas. Apply galvanizing repair paint to comply with ASTM A789.

END OF SECTION 23 05 29
SECTION 23 05 31 – PENETRATIONS 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. Refer to Division 23 Section “Wind Restraint Controls for HVAC” for wind restraint requirements related to this section.

1.2 SUMMARY

A. This Section includes the furnishing and installation of the major items listed below:
   1. Duct and pipe sleeves.
   2. Prefabricated curb assemblies. Curb for rooftop unit to be provided, installed, and designed by others as follows in this specification section and sections Division 23 “Sound and Vibration Control for HVAC” and Division 23 “Packaged, Outdoor Heating and Cooling Units”.
   3. Flashing and sealing of all mechanical openings through weather or waterproofed walls, roofs and floors.
   4. Sealing and finishing of all mechanical openings.
   5. Provide UL rated firestopping and sealing at all new and existing pipe penetrations of fire rated walls.

B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
   1. General Contractor:
      a. Locate and place all sleeved and framed openings as part of constructing the wall and floor surfaces in which the openings occur.
      b. Provide all lintels and required stiffening members for wall and floor openings.
      c. Cut roofing and install flashing for all required openings in proprietary roof membrane systems.
      d. Cut all roof deck openings and provide required framing supports.
   2. Mechanical Subcontractor:
      a. Advise General Contractor of quantity, location and size of all required openings.
      b. Provide all curbs, sleeves, seals, escutcheons and related materials required for finishing, sealing and waterproofing mechanical openings. Furnish all flashing and counterflashing.
      c. Arrange and pay for all openings required after wall, roof and floor construction is complete.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the Work of this Section shall comply with ASTM D2202 - Test Method for Slump of Sealants.

1.4 SUBMITTALS

A. Manufacturer's Literature: For all premanufactured curbs and sealing assemblies.
   1. Manufacturer's name.
   2. Model number.
   3. Details of construction and installation.
   4. Certified load-bearing data for all curbs.

B. Delegated-Design Submittal:
   1. Structural calculations for anchorage systems, sealed by the Professional Engineer responsible for the design.
   2. Clearly indicating design criteria and loadings used.
   3. For each vibration isolation device.
      a. Include design calculations and details for selecting vibration isolators complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.
1.5 PERFORMANCE REQUIREMENTS

A. Design Responsibilities:
1. Anchorage of outdoor equipment shall be designed by Contractor.
2. Minimum Requirements:
   a. Details, if any, indicated on the Drawings and Specifications contained herein are minimum requirements.
      1) Engineer has designed the structure to withstand the gravity and wind induced loadings of equipment.
      2) Notify Engineer of member size change requirements prior to fabrication.
   b. Generally comply with layouts and configurations as indicated on the Drawings.
3. Structural Performance:
   a. Design shall be performed by a professional engineer.
   b. Design shall comply with the building code plus amendments and local ordinances, if any, legally adopted for the location in which the Project is located.
   c. Design anchorage systems capable of withstanding design loads within limits and under conditions indicated.
      1) The term "withstand" means that the unit will remain in place without separation of any parts from the device when subjected to the wind forces specified.
   d. Design shall include systems that transfer gravity and wind induced loadings (including lateral, overturning and uplift effects) to the structure, including, but not limited to:
      1) Anchorage between units and curbs.
      2) Anchorage between curbs and building structure.
      3) Spacers, blocking, straps and the like.
4. Design Loads:
   a. Dead Loads: Actual weights of materials and fixed equipment, as calculated by designer.
   b. Wind-Restraint Loading:
      1) Determined by designer in accordance with the basic parameters indicated on the Drawings and procedures indicated in the Building Code.
      2) Design shall not consider shielding by adjacent structures.
5. Sound and Vibration isolated curb with performance requirements as detailed in specification section Division 23 “Sound and Vibration Control for HVAC”.

1.6 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
1. Trained and experienced in the fabrication and installation of the materials and equipment.
2. Knowledgeable of the design and the reviewed submittals.
B. Codes and Standards: "Architectural Sheet Metal Manual" as published by SMACNA.
C. Openings in Fire-Rated Surfaces: As specified in Division 07 Section “Penetration Firestopping.”
D. Delegated Designer Qualifications:
1. Professional Engineer licensed in the state in which the Project is located.
2. Having experience in a minimum of 5 projects in the last 10 years of comparable or greater complexity

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Curbs:
1. Thybar (Thycurb) Corporation.
2. The Pate Company.
4. Curbs, Inc.
B. Pipe Seals and Boots:
1. The Pate Company.
2. Portals Plus, Inc.
4. Thunderline Corporation.
5. Thycurb Corporation.

C. Modular Mechanical Seals:
1. Thunderline/Link-Seal.
2. As approved.

D. Backer Rod: Industrial Thermo Polymers, "Standard Backer Rod".

E. Acoustical Sealant: Pecora, “BA-98”.

F. Expanding Resilient Foam: General Electric, “RTF762.”

2.2 MATERIALS

A. Backer Rod:
1. Extruded round, closed cell, polyethylene foam.
2. Resilient, non-exuding.
3. Density: 2.0 pounds per cubic foot.
4. Tensile Strength: 50 psi.
5. Nonabsorbent to water and gasoline.
6. Suitable for use as a backing for acoustical sealant.
7. Compatible with sealant and approved by sealant Manufacturer.

B. Acoustical Sealant: Nonfire-Rated Penetrations:
1. Non-drying, non-hardening and non-bleeding.
2. Laboratory tested sealant which effectively reduces airborne sound transmission through wall systems.
3. Viscosity: 350,000 to 400,000 (Brookfield No. 65, 10 RPM).
4. Aging: Firm but rubbery, good tack after 50 days conditioned at 160 degrees F.
5. Slump: 0.1 to 0.2-inch in accordance with ASTM D2202.

C. Packing Material for Penetrations:
1. Glass Fiber or Mineral Fiber:
   a. Noncombustible.
   b. Resistant to water, mildew, and vermin.
2. Expanding Resilient Foams:
   a. Acceptable alternative if manufactured for this purpose.
   b. Minimum material density: 60 pounds per cubic foot.
3. Fire-Rated Penetrations: Permanently flexible, approved firestop putty. Refer to Division 07 Section “Penetration Firestopping.”

2.3 SLEEVES

A. Materials:
1. 18-Gage Galvanized Steel:
   a. For ductwork openings.
   b. For pipe penetrations in non-bearings walls.
2. Schedule 40 Steel Pipe:
   a. For all bearing walls.
   b. For all floors.
   c. For all concrete or masonry walls.
3. Cast Iron Pipe: For all exterior below grade installations.
B. Size All Sleeves:
1. To allow for movement due to expansion, without contact to pipe or insulation.
2. To provide for continuous insulation, except as required by Division 07 Section “Penetration Firestopping.”
3. As indicated on the Drawings.

2.4 MANUFACTURED UNITS

A. Structural Roof Curbs:
1. Frames:
   b. Corners: Mitered and welded (welds are micro sealed and prime painted after fabrication). Bolted connections are not accepted.
   c. Base Plates: Integral to frame and welded.
   d. Internally reinforced with galvanized 1-inch x 1-inch angles for curbs exceeding 3-foot length. Reinforce internal bulkhead at equipment curbs to support lateral loads.
   e. Wood Nailers: Factory installed, decay resistant. Size and width as suitable for support of items installed on curbs and perimeter of roof deck.
2. Curb Height:
   a. Minimum 18 inches above finished roof surface. Select roof curb so mechanical equipment air inlets are at least 18 inches above the finished roof surface and adequate space is provided for access doors.
   b. Select curb height so that grease duct flange/top of curb is at least 18 inches above finished roof surface with base set on roof structure under the roof decking.
3. Construct curbs to match roof slope with plumb and level top surface for mounting mechanical equipment.
4. Gasketing: 1/4-inch thick, 1-inch wide under all units.
6. Insulation: Minimum 1-1/2-inch, 3-pound density fiberglass insulation.
7. Curb assembly shall be installed under metal roof deck. Perimeter steel roof deck shall be supported by structural curb assembly. Structural curb bottom flange shall be a minimum width of 2 inches to support roof deck. Steel clips shall be provided where roof deck flutes do not contact bottom flange of structural curb, to prevent crushing roof deck.
9. Provide two access doors, minimum size 18”x18” on both sides of roof curb for access to duct fire dampers.

B. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Division 23 Section "Wind Restraint Controls for HVAC" for wind-load requirements.

C. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.

D. Exterior Roof Pipe Opening Seals:
1. Compatible with installation conditions.
2. Equal to One of the Following:
   a. Pate “Pipe Seal”.
   b. Pate “Pipe Curb Assembly”.
3. Link-Seal.
E. Modular Mechanical Seals:
1. Provide modular, mechanical type, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.
2. The elastomeric element shall be sized and selected in accordance with Manufacturer's recommendations and have the following properties as designated by ASTM:
   a. For Standard Service Applications:
      1) -40 to +250 degrees F (-40 to +121 degrees C).
      2) EPDM = ASTM D2000 M3 BA510.

PART 3 - EXECUTION

3.1 ROOF OPENINGS

A. Ducts:
1. Pass through prefabricated curbs.
2. Curb Counterflashing:
   a. Provide formed galvanized sheet metal in accordance with Division 07 Section "Sheet Metal Flashing and Trim."
   b. Solder or pop-rivet with mastic to the duct and extended over and down the top of the curbs for a minimum distance of 2 inches.
   c. Secure to the sides of the wood strips with corrosion-protected lag screws and washers 12 inches on center.
   d. Provide access door for access to fire dampers. Size to be minimum 18”x18”.

B. Piping:
1. As indicated on the Drawings.
2. For Multiple Pipes Through Single Opening:
   a. Select sleeve or opening seals of ample size to accommodate pipes.
3. Fill Annulus Opening:
   a. Use non-combustible insulation material.
   b. Full depth of sleeve.
4. Provide Moisture Protection Using Premanufactured:
   a. Elastomeric boot.
   b. Metal hood.
   c. Flashing fitting.

C. Locate curbs and sleeves a minimum of 12 inches from walls to permit proper flashing.

3.2 INTERIOR WALL AND FLOOR OPENINGS

A. Seal airtight all openings around pipes and ducts in the structure at:
1. Mechanical equipment rooms.
2. Penetrations of all drywall ceilings and concrete slabs suspended on isolators.
3. All enclosed shaft penetrations.

B. Duct Penetrations:
1. Where each duct passes through a wall, floor, or ceiling, there shall be a clear annular space of 1-inch (25 mm) between the duct and structure.
2. Frame, sleeve, or grout all voids in opening perimeter to contain packing material.
3. After all of the ductwork is installed, check the clearance, and pack the voids full depth with packing material. In noise-critical walls and floors, caulk both ends with acoustical sealant backed by a backer rod or permanently flexible firestop material.
4. Where there is not sufficient access space to pack around all sides of a duct (for example, at the underside of a slab), first place a short stub duct in the wall, pack and caulk around it, and then attach the inlet and outlet ducts to each end.
5. Where ducts enter or leave a shaft or pass through a wall or slab in sufficient numbers and density that individual pack-and-caulk details are not possible, special isolation details shall be developed:
   a. Before the shaft is fully enclosed, seal the penetration with a heavy membrane surrounding the ducts on each side of the wall or slab being penetrated.
b. Each membrane may be 2 layers drywall, 1-inch (25 mm) plaster or 14-gage lead sheet.
c. Other materials may be acceptable.
d. Pack the void between the 2 membranes with packing material or pump full of resilient closed cell firestop foam.
e. Calk all edges airtight.
f. In all cases, the proposed detail shall be approved by Engineer.

C. Pipe Penetrations:
   1. HVAC Piping:
      a. Where a pipe passes through a wall, ceiling, or floor, place cast or grout a sleeve into the structure.
      b. Internal diameter of the sleeve: 2 inches (50 mm) larger than the external diameter of the bare pipe or pipe insulation O.D. passing through it.
      c. After all of the piping is installed in a specific area, check the clearance and correct it, if necessary, to within 1/2-inch (12 mm).
      d. Pack the void full depth with packing material and seal at both ends, with minimum 1-inch (25 mm) deep sealant.
      e. In noise-critical walls and floors, pack with acoustical sealant backed by foam rod.
      f. Where pipes pass through a masonry wall in sufficient numbers and density that individual pack-and-calk details are not possible, a special isolation detail shall be developed:
         1) Cast pipe sleeves in a block of concrete with the sleeves located a minimum of 2 inches (50 mm) apart.
         2) Block thickness: At least as thick as the surrounding wall construction.
         3) Each sleeve diameter: 2 inches (50 mm) larger than the external diameter of the pipe passing through it.
         4) Build the sleeved block into the wall.
         5) After the pipes are installed, pack and caulk voids as indicated above.

3.3 FLOOR SLEEVES IN POTENTIALLY WET AREAS

A. All floors except slabs on grade.
B. Extend sleeves 3 inches above finished floor.
C. Provide poured concrete curb for duct openings as indicated in the Drawings.

3.4 ESCUTCHEONS AND CLOSURE COLLARS

A. Includes penetrations of ceilings, partitions, floor and walls.
B. Provide Escutcheons for All Piping Exposed to View:
   1. As indicated on the Drawings.
   2. Sized to fit over coverings.
   3. In All Potentially Wet Areas: Stainless steel.
   4. In All Dry Finished Areas: Chrome plated.
   5. Do not use escutcheons in acoustic isolation walls unless otherwise indicated.
C. Provide Sheet Metal Closure Collar for all Ductwork:
   1. Fit snugly around duct or covering, and surface penetrated without contact.
   2. Attach with approved fasteners 6-inch centers maximum spacing.
   3. Fabricate with minimum 4-inch face.

END OF SECTION 23 05 31
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 furnishing and installation of all equipment for and related items incidental to isolation and attenuation of mechanical vibration and sound:
   1. Major Items:
      a. Isolate mechanical rotating or vibrating equipment with vibration isolators.
      b. Connect ductwork and piping to equipment by means of flexible connections.
      c. Install mechanical equipment, piping and ductwork on, or suspended from, approved and specified foundations or supports.
      d. Install internal acoustical duct lining as indicated on Drawings or specified herein.
   2. All vibration isolation devices shall be furnished by a single Manufacturer.

B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
   1. Mechanical Subcontractor:
      a. Provide miscellaneous structural steel necessary for support of mechanical work.
      b. Coordinate necessary alterations in structural steel.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   3. ASTM:
      h. G21 - Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
      i. G22 - Practice for Determining Resistance of Plastics to Bacteria.
   5. NFPA Standard:
      a. 90A - Installation of Air Conditioning and Ventilating Systems.
   6. SMACNA: HVAC Duct Construction Standards - Metal and Flexible.
   7. UL: 181 - Factory-Made Air Ducts and Air Connectors.
1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. The isolation materials Manufacturer shall be responsible for the proper selection of isolators to achieve the specified minimum static deflections, for all isolators, based on the actual weight distribution of equipment to be isolated.

B. The isolation materials Manufacturer shall be responsible for the structural design of steel beam bases and concrete inertia bases, to support mechanical equipment scheduled to receive such supplementary bases.

C. Be responsible for verifying the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this Specification. All additional equipment needed to meet the intent of this Specification, even if not specifically mentioned herein or in the Contract Documents, shall be supplied by the Contractor without claim for additional payment.

D. Sealing of Penetrations: Designated building structures designed to isolate air-borne noise surrounding all critical and noisy spaces. Proper routing of and sealing or lagging (enclosure), or both, around mechanical services penetrating these structures are necessary to maintain the integrity of the isolating structure.

E. Structural Isolation: Separations of building structures along acoustical joints have been designed to reduce structure-borne transmission of sound into critical spaces. Mechanical and electrical services must avoid rigid bridging across two structures isolated from each other.

1.5 SUBMITTALS

A. Manufacturer's Literature: For all products described under Part 2 of these Specifications.
   1. General:
      a. Dimensions.
      b. Construction details.
      c. Manufacturer’s name.
      d. Model number.
   2. Spring Isolators:
      a. Rated deflection.
      b. Spring constant.
      c. Model number.
      d. Type of isolator.
      e. Size.
      f. Height when uncompressed and maximum allowed static deflection.
      g. Isolator location shown on an outline of the isolated equipment.
      h. Detail drawings of inertia bases isolators.
      i. Location of isolators on plan drawings of the isolated area, where applicable.
      j. The weight of all isolated equipment, and the loads on each isolator and the static deflection of each isolator under the specific design load shall be listed along with the proposed isolators.
      k. Pipe isolators shall be shown and identified on piping layout Drawings.
   3. Duct Lining:
      a. Certified acoustical performance through octave bands from 63 Hz to 8000 Hz.
      b. Air pressure drop.

B. Furnish a complete set of approved Shop Drawings of all mechanical and electrical equipment to receive vibration isolation devices to the vibration isolation materials Manufacturer, based upon the selection of vibration isolators and design of supplementary bases will be completed. The Shop Drawings to be furnished shall include operating weights of the equipment to be isolated and the distribution of weight at support points.

1.6 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.
B. Manufacturer or Qualified Representative Services:
   1. Provide necessary field supervision.
   2. Ensure correct installation and adjustment.

C. Regulatory Agencies Requirements:
   1. Comply with all state and local codes and ordinances.
   2. Insulation, facing, and adhesive shall have a composite rating:
      a. 25 flame spread maximum.
      b. 50 smoke developed maximum.
      c. In accordance with NFPA 255.
   3. Installation of acoustic duct liner shall be in accordance with:
      a. SMACNA - HVAC Duct Construction Standards - Metal and Flexible:
         1) Acoustical Liner Installation Standards.
         2) Mechanical Fastener Standard.
      b. NAIMA - Fibrous Glass Duct Liner Standards.

1.7 DELIVERY, STORAGE, AND HANDLING

A. All materials shall be delivered in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer’s directions.

C. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Flexible Duct Connectors:
   1. Ventfabrics; "Ventglas and Ventsil".
   2. Duro Dyne; "Neoprene".

B. Vibration Control: All vibration control apparatus shall be provided by a single Manufacturer except as specifically noted herein:
   1. Amber-Booth.
   2. Mason Industries, Inc.

C. Acoustic Duct Liner:
   1. Armacell AP Coilflex closed-cell elastomeric acoustical duct liner.
   2. Equivalent by Johns Manville.
   3. Equivalent by Knauf.

D. Acoustic Duct Liner Adhesives:
   1. Foster Products.
   2. Baldwin-Ehret-Hill.
   3. Armstrong.
   5. Precision Adhesive, Inc.
   6. Mon-Eco Industries, Inc.

E. Sound Isolation Extended Base:
   1. Greenheck; "ATE".
   2. Pate.
   3. Cook.
F. Acoustic Rooftop Unit Insulation:
   1. United States Gypsum Company.
   2. Engineer approved equal.

G. Vibration Isolation Curbs:
   1. Thybar Corporation.
   2. Pate.
   4. Mason.

H. Acoustic Duct Lagging:
   2. Engineer approved equal.

2.2 MATERIALS

A. Acoustic Duct Liner:
   1. Shall only be used where noted on drawings.
   2. Elastomeric closed-cell duct liner, fiber free.
   3. Density: 1.9 pounds/cubic foot.
   5. Thermal Conductance (c): 0.25 at 75 degrees F mean temperature.
   6. Acoustical Performance:

<table>
<thead>
<tr>
<th>Octave Band Center Frequencies (Hz)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1,000</th>
<th>2,000</th>
<th>4,000</th>
<th>NRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Sound Absorption</td>
<td>0.08</td>
<td>0.22</td>
<td>1.03</td>
<td>0.37</td>
<td>0.68</td>
<td>0.50</td>
<td>0.52</td>
</tr>
</tbody>
</table>

   7. Facing:
      a. Factory-applied black acrylic coating.
      b. Fire-Resistant:
         1) Comply with NFPA 90A.
         2) UL listed.
         3) 25 flame spread and 50 smoke developed rating.
      c. Rated for velocities at 10,000 fpm tested in accordance with UL 181 without wearing of the surface
         or entrainment of glass fibers into air stream.
      d. Designed to minimize friction loss.
      e. The insulation must be resistant to microbial growth as determined by:
         1) UL 181: Mold Growth and Humidity Test.
         2) ASTM C1071: Fungi Resistance Test.
   8. Use Johns Manville “Permacote Superseal” for edge coating and in areas requiring repair.

B. Duct Liner Fasteners:
   1. Mechanically Secured:
      a. 12-gage galvanized steel.
      b. Impact-driven into duct.
      c. Form positive mechanical attachment to sheet metal.
      d. Fastener shall not compress the insulation more than 1/8-inch.
   2. Weld-Secured:
      a. Attached to Duct by:
         1) Resistance welding.
         2) Capacitance discharge welding.
      b. Fastener Head:
         1) 0.075 square inch minimum area.
         2) 0.01-inch minimum thickness.
         3) Cupped or beveled.
         4) Shall not compress the insulation more than 1/8-inch.
C. Acoustic Duct Liner Adhesives:
1. As recommended by Manufacturer of insulation.
2. Solvent or water-based.
3. Fire-resistant: 25 flame spread and 50 smoke developed rating.

2.3 VIBRATION ISOLATION EQUIPMENT

A. Vibration Isolation Curb:
1. Isolation assembly shall consist of extruded aluminum upper and lower members incorporating cadmium plated steel springs with 1-inch static deflection and insuring uniform deflection for the entire system.
2. Spring diameter shall be equal to or greater than the loaded spring height and shall be equal to 50% of the rated deflection.
3. A continuous flexible waterproof seal shall be riveted to both upper and lower members. Assembly shall include both upper and lower gasket material.

B. Flexible Duct Connectors:
1. Flexible sleeves for duct connections shall be fabricated from flexible, airtight, coated fabric. Each sleeve shall be installed with at least 3 inches (75 mm) slack across a clear metal to metal gap of at least 4 inches (100 mm). That is, 7 inches (175 mm) of this fabric is required for each sleeve.
2. Standard Temperature Type:
   b. Coated Fabric Weight: 30 ounces per square yard.
   c. Thickness: 0.024-inch.
   d. Temperature Range: -20 to 200 degrees F.
   e. Tensile Strength:
      1) 480 pounds per inch warp.
      2) 360 pounds per inch fill.

C. Isolation Hangers:
1. Isolator Type DDNH:
   a. Type DDNH (double deflection neoprene hangers) shall consist of a molded neoprene isolating element in a steel hanger box. A neoprene grommet extending from and continuous with the main neoprene element shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 3/4-inch (19 mm) larger than the diameter of the hanger rod and permit the hanger rod to swing through a 30-degree arc. When installed, the hanger box shall be allowed to rotate through a full 360 degrees without encountering any obstructions.
   b. Unless otherwise specified, the static deflection of DDNH hangers shall be 0.3 inches (8 mm) with a strain not exceeding 15%. Neoprene shall be bridge-bearing quality with a maximum durometer (Shore A scale) of 50.
   c. Type DDNH: Mason Industries Type HD; or as approved by Engineer.

D. Spring Isolators:
1. Isolator Type CSNM:
   a. Type CSNM (constrained spring and neoprene mounts) shall be a spring and neoprene mount that incorporates a housing which includes vertical limit stops to prevent spring expansion when weight (water or other fluid) is removed from the equipment and limits the movement of equipment when it is subjected to wind loading. A minimum clearance of 1-inch (25 mm) shall be maintained around restraining bolts and between the housing and the spring, so as not to interfere with the spring operation. Limit stops shall be out of contact during normal operation, backed away from contact by at least 1/2-inch (12 mm); a neoprene washer shall be installed beneath the bolt head/washer used to restrain the isolator. In outdoor rooftop installations isolators must be bolted to the roof or supporting structure with a neoprene mounting sleeve.
   b. Unless otherwise specified, the minimum static deflection for Type CSNM mounts shall be 2 inches (50 mm).
   c. Type CSNM: Mason Industries Type SLR; or as pre-approved by Engineer.
E. Neoprene Mounting Sleeves: Neoprene mounting sleeves for hold-down applications of equipment with vibration isolators shall be Uniroyal Type 620/660; or as pre-approved by Engineer.

F. Sound Isolation Extended Base:
   1. Construction:
      a. Galvanized steel construction.
      b. Continuous mitered and welded corner seams.
      c. Base compatible with roof curb.
      d. 1-1/2-inch thick, 6 pounds per cubic foot density rigid glass fiber insulation around interior curb wall.
      e. Baffle:
         1) Aluminum die formed sections.
         2) fiberglass wool fill.
         3) Spring steel wire holding clips to allow baffle removal.
   f. Performance: 50% reduction of sound level.

G. Duct Lagging:
   1. Install on ductwork where noted on the drawings
   2. Kinetics KNM-100AL.

PART 3 - EXECUTION

3.1 GENERAL

A. Piping, ductwork, conduit or mechanical equipment shall not be hung from or supported on other equipment, pipes, or ductwork installed on vibration isolators. It shall be supported on or suspended from building structure.

B. Equipment connected to fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Equipment should be blocked-up with temporary shims to final operating height. When the system is assembled and fluid is added, the isolators shall be adjusted to allow removal of the shims, and confirm that the isolators for the fluid-filled pipes, pumps, and other elements deflect the specified amounts and no more.

C. All mechanical equipment not specifically identified in this Specification that contains rotating or vibrating elements, and all associated electrical apparatus installed by this division that contains transformers or inductors shall be installed on Type DDNM or RBA neoprene isolators as appropriate. In all such instances, submit the proposed isolators with the isolator Shop Drawings.

D. All isolators that are to be installed outdoors or exposed to the weather shall be hot-dipped galvanized and shall be furnished with neoprene mounting sleeves for hold-down bolts to prevent any metal-to-metal contact.

E. Elastomeric isolators that will be exposed to temperatures below 32 degrees F (0 degrees C), shall be fabricated from natural rubber instead of neoprene.

F. Wiring:
   1. All wiring connections to mechanical equipment on vibration isolators (either spring or neoprene type) shall be made with a minimum 36-inch (1 m) long flexible conduit in a 360-degree loop.
   2. All ties used to form the loop shall be removed prior to adjusting the isolators.

3.2 FAN ISOLATION

A. Roof-Mounted Equipment:
   1. Roof-mounted packaged air-conditioning units shall be installed on rooftop isolation curbs using Type CSNM isolators.
   2. All hardware must be plated or galvanized to provide a rust-resistant finish. Weather-proofing shall be provided by a continuous flexible seal.
   3. All springs shall have removable waterproof covers to allow for adjustment or replacement of the springs.
4. Coordinate rooftop unit installation with Division 23 section “Wind Restraint Controls for HVAC”, Division 23 section “Penetrations for HVAC”, and Division 23 section “Packaged, Outdoor Heating and Cooling Units.”

3.3 SHEET METAL DUCTWORK

A. Duct Isolation: Supply and return ducts as noted on the drawings shall be supported on Type DDNH isolators after the air handling unit is in place.

B. Ductwork Fabrication: Fabricate ductwork so as to be free from vibration, rattle, or drumming under all operating conditions; provide all materials necessary for specified construction, whether or not they are specifically called for or detailed on the Drawings.

C. Bracing of Ductwork: Do not install tie rods inside ducts.

D. Ductwork Wall Penetrations: Seal around ductwork wall penetrations as specified in Division 23 Section “Penetrations for HVAC.”

3.4 ACOUSTIC LINING OF DUCTS

A. Application:
   1. Ducts, where noted on the drawings, shall be acoustically lined internally, from the air moving device as noted on the drawings:
      a. Both supply and return systems from the package rooftop unit where noted on the drawings.
      b. Where indicated on the Drawings.

B. Thickness:
   1. Lining shall be 2 inches (50 mm) thick in immediate supply and return ducts from rooftop unit as indicated on the Drawings.
   2. Where internal lining is also specified in Division 23 Section “Duct Insulation” for thermal duct lining, the greater thickness shall be used.

C. Installation:
   1. The acoustic liner shall be fixed to the duct with a minimum of 50% coverage of a fire-resistant adhesive. All perimeter acoustic liner edges shall be coated with adhesive.
   2. Where the duct width exceeds 12 inches (300 mm) or a height of 24 inches (600 mm), the liner shall be additionally secured with mechanical fastening on maximum 16-inch (400 mm) centers, and no more than 3 inches from ductwork edges or insulation joints.
   3. Mechanical fasteners that pierce the duct are unacceptable.
   4. All portions of duct specified to receive acoustic liner shall be completely covered.
      a. Transverse joints shall be neatly butted and there shall be no interruption or gaps.
      b. All transverse edges are to be 100% covered with Manufacturer-supplied edge coating.
      c. Cut liner to ensure tight corner joints.
      d. All corner joints are to be either lapped and butted, or folded.
      e. Black coated surface is to face air stream.
   5. Acoustic liner shall be 100% covered with Manufacturer supplied coating at all exposed surfaces, edges, and transverse joints.
   6. Where acoustic duct lining is installed, the dimensions of the sheet metal shall be increased to include the thickness of the lining material. Dimensions indicated on the Drawings are the net clear internal dimensions after the acoustic liner has been installed.
   7. Exposed and leading edges will be covered with metal nosing around the entire perimeter.

3.5 MISCELLANEOUS EQUIPMENT

A. Flexible Duct Connectors:
   1. Install at duct connections to air moving equipment.
   2. Install at locations indicated on Drawings.
3.6 FIELD QUALITY

A. Work in accord with best trade practices, fabricate and install all items in accordance with Manufacturer’s recommendations and Engineer’s directions, and consult with trades doing adjoining work in order to provide an installation of first class quality.

3.7 ADJUSTMENT AND TESTING

A. Site Access: During installation of equipment, arrange for access as necessary for inspection of isolation and noise control equipment by Engineer.

B. Inspection:

1. Upon completing installation and adjustment for suitable operation of all work specified under this Section, notify Engineer in writing, who will schedule a review.
2. The Contractor’s letter shall certify that all work specified under this Section is complete, operational, and adjusted in every respect, and that all work under this Section is ready for the completion checkout.
3. The notification letter shall be accompanied by a copy of the air balancing report.
4. For each inspection, workmen shall be furnished to perform such functions as are necessary for inspection of the equipment.
5. Measurement of background noise levels by the Engineer requires that there be a minimum of extraneous noise.
6. Such measurements must be scheduled during late-night hours when there is no work taking place on the site.
7. Workmen shall be employed during the testing procedure to turn on and off all mechanical and electrical equipment for such background noise level testing.

END OF SECTION 23 05 46
SECTION 23 05 48 - WIND RESTRAINT 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. Section Includes:
   1. Restraint channel bracings.
   2. Restraint cables.
   3. Mechanical anchor bolts.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   2. ASTM Standard Specifications:

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Submit for delegated design anchorage systems.
   2. Drawings of all designed components, stamped by the professional engineer responsible for the design.
   3. Fully dimensioned and detailed.

C. Delegated-Design Submittal:
   1. Structural calculations for anchorage systems, sealed by the professional engineer responsible for the design.
   2. Clearly indicating design criteria and loadings used.
   3. For each vibration isolation and wind restraint device.
      a. Include design calculations and details for selecting vibration isolators and wind restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding Certificates: Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

B. Delegated Designer Qualifications:
   1. Professional engineer licensed in the state in which the Project is located.
   2. Having experience in a minimum of 5 projects in the last 10 years of comparable or greater complexity.
1.7 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:
   1. Determined by designer in accordance with the basic parameters indicated on the Drawings and procedures indicated in the Building Code.

B. Design Responsibilities:
   1. Anchorage of equipment, piping and ductwork shall be designed by Contractor.
   2. Minimum Requirements:
      a. Details, if any, indicated on the Drawings and Specifications contained herein are minimum requirements.
         1) Engineer has designed the structure to withstand the gravity and wind induced loadings of equipment.
         2) Notify Engineer of member size change requirements prior to fabrication.
      b. Generally comply with layouts and configurations as indicated on the Drawings.
   3. Structural Performance:
      a. Design shall be performed by a professional engineer.
      b. Design shall comply with the building code plus amendments and local ordinances, if any, legally adopted for the location in which the Project is located.
      c. Design anchorage systems capable of withstanding design loads within limits and under conditions indicated.
         1) The term "withstand" means that the unit will remain in place without separation of any parts from the device when subjected to the wind forces specified.
      d. Design shall include systems that transfer gravity and wind induced loadings (including lateral, overturning and uplift effects) to the theatre structure, including, but not limited to:
         1) Anchorage between units and curbs.
         2) Anchorage between curbs and theatre structure.
         3) Spacers, blocking, straps and the like.

C. Design Loads:
   1. Dead Loads: Actual weights of materials and fixed equipment, as calculated by designer.
   2. Wind Loads:
      a. Determined by designer in accordance with the basic parameters indicated on the Drawings and procedures indicated in the Building Code.
      b. Design shall not consider shielding by adjacent structures.

PART 2 - PRODUCTS

2.1 RESTRAINT CABLES

A. Restraint Cables: ASTM A 603 galvanized steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Kinetics Noise Control, Inc.
      b. Loos & Co., Inc.
      c. Vibration Mountings & Controls, Inc.

PART 3 - EXECUTION

3.1 ADJUSTING

A. Adjust and tighten fasteners to securely hold.

END OF SECTION 23 05 48
SECTION 23 05 93 – 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. This Section includes a description of the mechanical system testing, adjusting and balancing (TAB) scope of services. The following systems shall be included in the testing, adjusting, and balancing process:

1. Air handling/air distribution systems.

B. Test and Balance Contractor will be contracted through Wayne State University.

C. Division of Work:

1. In accordance with the General Conditions, Contractor shall be responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.

2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:

a. Mechanical Subcontractor:

1) Provide related work as specified herein to support the mechanical systems TAB work being performed by TAB engineer.

2) Provide access to all balancing devices.

3) Provide replacement fan sheaves and impellers:

   a) At no additional cost to Owner.

   b) As required to achieve design performance for mechanical equipment.

4) Perform system start-up functions including, but not necessarily limited to:

   a) Venting air from all hydronic system piping and components.

   b) Setting all manually operated dampers and valves in the full open position.

   c) Complete and submit pre-test and balance checklist to Engineer and TAB engineer prior to start of TAB work.

5) Correct all mechanical system deficiencies identified by TAB engineer.

b. TAB Engineer:

1) Provide timely notice to mechanical Subcontractor and TCS Subcontractor of all incomplete work and deficiencies which prevent proper performance of test and balance work.

2) Test, adjust and balance all air and hydronic systems and prepare final report.

 c. Temperature Control System (TCS) Subcontractor:

1) Provide related work as specified herein to support the mechanical systems TAB work being performed by TAB engineer.

2) Operate all temperature control devices to support TAB work that is dependent on various control operating modes.

3) Correct all TCS system deficiencies identified by TAB engineer.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:

1. Sheet Metal and Air Conditioning Contractor's Association (SMACNA) publications:

   a. Procedural Standards for Testing, Adjusting, and Balancing of environmental systems.


1.4 DEFINITIONS

A. Proper Performance Characteristics:
   1. In accordance with design intent, acceptable energy efficiency and Manufacturer's recommendations.
   2. Providing acceptable thermal and acoustical performance in all service areas.
   3. As directed by Engineer.

B. TAB Engineer: An individual, firm or corporation whose primary work is testing, adjusting and balancing environmental systems working under a direct contract to the Owner.

1.5 SUBMITTALS

A. Submit Pre Test and Balance Checklist and mechanical systems TAB report in accordance with Division 01 Section “Submittal Procedures.”

B. Submit Pre Test and Balance Checklist at least 2 weeks prior to scheduled start of TAB work as scheduled by Contractor and approved by Owner.

C. Preliminary TAB Submittal:
   1. Prior to final inspection.
   2. 3 copies to Engineer.

D. Final Submittal: 5 copies to Engineer.

E. The TAB report shall include, but not necessarily be limited to, the following general items:
   1. Summary remarks regarding problems.
   2. Initial, interim and final performance test data.
   3. Description of test procedures and equipment used.
   4. Systems' Drawings and/or schematics clearly marked to identify location of equipment tested, duct traverse location(s), location of system static pressure sensor, etc.
   5. Systems performance data sheets shall include design conditions, installed equipment information, and field test data for:
      a. Air Systems:
         1) Design Conditions:
            a) Air capacity.
            b) System total static pressure drops and profiles of all air handling systems, including filters, coils, etc.
            c) Motor horsepowers and design brake horsepowers.
            d) Fan speeds.
            e) Fan curves or fan rating tables showing design conditions.
         2) Installed Equipment:
            a) Equipment Manufacturer.
            b) Equipment model numbers, sizes, types, etc.
            c) Motor types, sizes and characteristics.
            d) Heater and starter types, sizes and characteristics.
            e) Drive types, sizes and speed range.
            f) Equipment ratings if different from design.
            g) Identification of all terminal devices, including outlets.
            h) Location of all smoke control devices.
         3) Field Test Data - Initial and Final Test Readings For:
            a) Air capacities.
            b) Static pressures through units and unit components.
            c) Equipment speeds.
            d) Motor operating voltages and amperages.
            e) Brake horsepower.
            f) Operating performance plotted on fan curves or fan rating tables.
            g) System schematic and notes including measured static pressure values, system static pressure sensor values, etc.
h) Airflow and static pressure data for all duct mains as balanced under typical total system operation. Report will not be accepted without airflow and static pressure profile (refer to Paragraph 3.3).

i) Identify each outlet or inlet as to location, area, size and fan system.

j) Required and field measured cfm for each outlet or inlet.

1.6 QUALITY ASSURANCE

A. Qualifications:
   1. TAB Field Technician Personnel:
      a. Trained and experienced in the operation of the test and balance equipment.
      b. Knowledgeable of the design of all systems scheduled for testing and balancing.
   2. TAB Engineer:
      a. A certified member of either the following organizations or trained in the practices thereof:
         1) AABC.
         2) NEBB.
      b. Acceptable firms providing testing, adjusting, and balancing services include:
         1) Absolut Balancing Company, South Lyon, Michigan.
         2) International Test & Balance, Southfield, Michigan.
         3) Total Balance Company, St. Claire Shores, Michigan.
         4) As approved (approval required prior to bid submittal).

B. Report Forms:
   1. The report forms included in the appendix of the AABC Standard are incorporated in the work of this Section for the purpose of identifying the level of detail required for testing and reporting.
   2. TAB engineer may use the AABC forms or other similar forms which present equivalent information in a logical format.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Patching Materials:
   1. Comply with requirements as specified in other Sections where applicable to provide materials essentially and functionally identical to original installation before testing and balancing work.
   2. Maintain the integrity of systems for air tightness, water tightness, and durability of finish.

2.2 INSTRUMENTS

A. Instruments used for TAB work shall be as indicated in the referenced standards.

B. Calibration:
   1. Instruments to have been calibrated within one year of start of TAB work.
   2. Appropriate documentation shall be made available to the Engineer on request.

PART 3 - EXECUTION

3.1 PROCEDURES

A. General:
   1. Determine what actual performance characteristics are deemed proper during system tests.
   2. If the design supply, return or exhaust air quantities for a space create a space pressure other than neutral, or if a space is indicated to be a certain pressure, provide balancing to the extent required to achieve this designed pressure.
   3. During heating (and cooling) season of the first year of operation, at times when directed, make final adjustments until all occupants are reasonably satisfied and all equipment is operating at peak efficiency.
   4. Confirmation of proper equipment operation must be through actual observation. Computer simulation and sensor readouts are not acceptable proof.

/2
B. Air Systems:

1. General:
   a. Adjust and set all dampers, deflecting vanes, discharge vanes and accessory items to achieve proper air distribution and patterns in all parts of the air supply, return and exhaust systems:
      1) Determine air flow and static pressure in all branch ducts by velocity traverse and balance out all branches by means of branch duct manual dampers.
      2) Balance terminal outlets on each branch duct using volume dampers in run-out duct to the outlet, not the terminal outlet dampers.
   b. Mark final balance position for all dampers which are not left 100% open with an indelible pen.
   c. Adjust and set all belted fan speeds as required to attain proper total air flow.
   d. Measure supply fan total air flow at both the full return air and full outdoor air damper positions.
   e. Make smoke gun tests, if necessary, to check for drafts and make final adjustments and settings for optimum comfort conditions.

2. Methods: Acceptable procedures for obtaining performance measurements are listed below:
   a. CFM Airflow for Duct Sections:
      1) Duct traverse as specified in SMACNA Manual "HVAC Systems - Testing, Adjusting and Balancing," Chapter V, Section 4-B, using a pitot tube and inclined manometer.
      2) Acceptable Methods:
         a) Pitot tube array with reading by inclined manometer.
         b) Electronic manometer.
         c) Hot-wire anemometer.
   b. CFM airflow, for room supply, return and exhaust, at diffusers, registers and grilles: Use airflow hood.
   c. Fan TSP: Use inclined manometer.
   d. Equipment Pressure Drops: Use inclined manometer.
   e. Air Temperatures: Use thermometer.
   g. CFM Differential Airflow Reading:
      1) Block door entrance leaving 1 or 2 square foot measured opening.
      2) Read opening with thermal anemometer.
   h. Differential Pressure: In cases where sensors for differential pressure are permanently installed, differential pressure may be read directly using an Electronic Digital Manometer.

3. TAB Procedures for Air Systems:
   a. Check all motorized, balancing and gravity relief dampers for proper position.
   b. Inspect coils, filters and fans for cleanliness.
   c. "Bump" motor to check for proper fan rotation.
   d. Check unit performance including:
      1) Fan speed.
      2) Amperage and voltage.
      3) Suction, discharge and total static pressures at fan.
      4) Supply air volume of fan by taking duct traverse in discharge duct or zone ducts.
   e. Note: Check unit performance in both 100% outside air and 100% return air positions, including static pressures across individual equipment components.
   f. Set outside air motorized damper at proper minimum position.
   g. See that necessary adjustments or changes are made to achieve design airflow capacities or consult Engineer if change(s) required are beyond the scope of the TAB contract.
   h. Balance Medium and High Velocity Ductwork:
      1) Measure inlet static pressure and airflow at all terminal unit inlets through actual transverse. Flow sensor readings are not acceptable.
      2) If terminal unit has constant volume regulator or manual adjustment damper, make certain the correct maximum amount of air is being delivered.
      3) All measurements should be taken only when system is operating under normal operating conditions.
      4) If system is variable volume, set up diversity conditions where applicable and record static pressure at sensor(s).
      5) Set terminal unit minimum airflow capacities where applicable.
   i. Balance Low Velocity Ductwork:
      1) Take traverse and static pressure readings in main branch ducts and set balancing dampers for approximate correct distribution of air.
      2) Proportionately balance all branch ducts.
      3) Proportionately balance all outlets and inlets.
4) Make smoke gun tests to check for drafts and make final settings for optimum comfort conditions in occupied space.
5) Recheck supply air unit performance and make any necessary final adjustments. Include allowances for wet coil, dirty filters, and other normal operating conditions which may reduce air flow.
6) Record final measurements as required.

C. Testing Procedures for Refrigeration Systems:
1. Verify all installation details in reference to equipment Manufacturer's recommendations.
2. Verify proper setting of all operating and safety devices.
3. Verify split systems installation for the following:
   a. Line sizes.
   b. Piping standards.
   c. Pressure testing.
   d. Evacuation.
   e. Charging.
4. Measure equipment performance under conditions which closely approximate design conditions and record all performance data as required in Field Test Data Section.

3.2 FIELD QUALITY CONTROL

A. Preliminary Review and Analysis:
1. If after standard balancing procedures have been carried out and readjustments attempted, the system does not perform as specified, Engineer shall be notified at once.
2. All "as is" field data shall be submitted in a preliminary report for review and analysis.
3. Manipulation of system to achieve air flow and balance without meeting intended and specified total system air flow will not be accepted in a balance report. Should this occur, rebalance shall be at the Contractor's expense.

B. Final Inspection: Prior to final acceptance, all systems shall be operated to test performance as directed to the satisfaction of the Engineer:
1. Steam and water shall circulate throughout entire system without noise, evidence of leaks and trapping or air-binding.
2. Air in ducts shall circulate without excessive noise.
3. Motors, fans and other equipment shall operate without excessive noise or vibration.
4. Systems shall be balanced to operate within stated tolerances. If any heating unit, chilled water cooling coil, or air outlet does not operate within the stated tolerances, then the entire system shall be considered out of balance and shall be readjusted until all units are within the stated tolerances.
5. Heating, ventilating and air-conditioning systems shall maintain uniform temperatures without drafts.
6. Burners shall be tested and set for high efficiency and smokeless combustion.

C. Testing: TAB engineer will repeat system testing, adjusting, and balancing until Owner or Engineer verifies accuracy of data.

3.3 STATIC PRESSURE AND AIR FLOW PROFILE

A. Provide a static pressure and air flow profile diagram:
1. Air flow readings shall be based on a duct traverse.
2. Data shall reflect actual coincident system performance established at total system balance:
   a. Throttling of one branch below design to obtain design performance in another is not acceptable. Refer to Paragraph 3.2.A.
   b. Diversity in variable air volume systems shall be reflected on profile diagram.
3. Provide data for each duct main and a minimum of one set of readings for each floor for multiple floor systems.

3.4 PRE TEST AND BALANCE CHECKLIST

A. Contractor shall copy the following Pre Test and Balance Checklist (Exhibit B, attached) and submit one completed checklist for rooftop unit.
B. TAB engineer may be entitled to be compensated for additional time required due to failure of other Subcontractors to properly complete their work.
EXHIBIT B
PRE TEST AND BALANCE CHECKLIST

Equipment Tag No. _______________ Date: ____________________

As an aid to properly interface work between trades and prevent unnecessary return visits for everyone concerned, the TAB engineer requires that the following list of items be completed by the Mechanical Subcontractor prior to any testing and balancing of air and hydronic systems.

Work required is as follows:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Static pressure control sensors shall be installed in locations indicated on contract documents.</td>
</tr>
<tr>
<td>2.</td>
<td>Variable frequency controllers installed on fan drives shall be properly set up for minimum to maximum speed positions.</td>
</tr>
<tr>
<td>3.</td>
<td>Fan rotation is correct.</td>
</tr>
<tr>
<td>4.</td>
<td>Fan RPM is to be set after fan performance test by Test and Balance Contractor, however, initial installed RPM shall be within 10 percent of what was intended per equipment submittal.</td>
</tr>
<tr>
<td>5.</td>
<td>Verify that fan is running within motor nameplate amp draw at initial installed RPM.</td>
</tr>
<tr>
<td>6.</td>
<td>Balancing dampers shall be installed in locations shown on Contract Documents.</td>
</tr>
<tr>
<td>7.</td>
<td>Damper operators shall be installed with provisions for access and not covered with insulation.</td>
</tr>
<tr>
<td>8.</td>
<td>All (normal operational) dampers shall be set and locked in the 100 percent open position.</td>
</tr>
<tr>
<td>9.</td>
<td>All fire dampers shall be open with fuse links installed and any props removed. Any motor operated fire and smoke dampers are operating correctly.</td>
</tr>
<tr>
<td>10.</td>
<td>All filters shall be in place, including clean construction filters installed upstream.</td>
</tr>
<tr>
<td>11.</td>
<td>Terminal units shall be functioning with thermostat.</td>
</tr>
<tr>
<td>12.</td>
<td>Terminal units shall be sequencing properly with radiation valve (i.e., normally closed T.U. with normally open valve, etc.).</td>
</tr>
<tr>
<td>13.</td>
<td>Reverse acting (R.A.) thermostat shall be with N.O. terminal boxes and direct acting (D.A.) thermostat shall be with N.C. terminal boxes.</td>
</tr>
<tr>
<td>14.</td>
<td>All air shall be bled from hot or chilled water system.</td>
</tr>
<tr>
<td>15.</td>
<td>All (normal operational) valves shall be set in 100 percent open position.</td>
</tr>
<tr>
<td>16.</td>
<td>Memory devices shall be installed on all specified balancing valves.</td>
</tr>
<tr>
<td>17.</td>
<td>Installation of all temperature wells and gage cocks.</td>
</tr>
<tr>
<td>18.</td>
<td>Pressure taps shall be installed across body of pump and inlet and outlet of coils. Location of pressure taps shall be between isolation and check valves, etc., associated with coils.</td>
</tr>
<tr>
<td>19.</td>
<td>Hydronic systems shall have been cleaned and flushed and construction strainers removed from equipment.</td>
</tr>
<tr>
<td>20.</td>
<td>Pump rotation shall be correct.</td>
</tr>
<tr>
<td>21.</td>
<td>Verify that pump is running within motor nameplate amp draw at initial installed impeller size.</td>
</tr>
<tr>
<td>22.</td>
<td>All exhaust fans shall be wired, operable and in correct rotation.</td>
</tr>
<tr>
<td>23.</td>
<td>All multiple exhaust duct system balance dampers shall be installed and set 100 percent open.</td>
</tr>
<tr>
<td>24.</td>
<td>All relief air or backdraft dampers shall be set for proper operation, i.e., just closing.</td>
</tr>
</tbody>
</table>

END OF SECTION 23 05 93
SECTION 23 07 13 – DUCT INSULATION

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 furnishing and installation of thermal insulation applied to external surfaces of ductwork and air handling devices. Internal acoustical duct liner is not included in the work of this Section. Coordinate this work with duct liner requirements in accordance with Division 23 Section “Sound and Vibration Control for HVAC.”

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ASTM Specifications:
      c. C612 – Mineral Fiber Block and Board Thermal Insulation.
   2. NFPA Standard:
      a. 90A - Installation of Air Conditioning and Ventilating Systems.

1.4 SUBMITTALS

A. Manufacturer's Literature: For all thermal materials.
   1. Manufacturer product data brochure.
   2. Thermal performance characteristics - "K" Values.
   3. Details of construction and installation.
   4. Compliance with standards and UL listing.

B. Samples:
   1. Proposed substitutions for products other than those herein specified.
   2. Engineer's approval prior to installation.
   3. Fire barrier shall have the following ratings:
      a. Flame Spread Maximum: 0.
      b. Smoke Developed Maximum: 0.
      c. In accordance with ASTM E84.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.
B. Regulatory Agencies Requirements:
   1. State and local codes and ordinances.
   2. Insulation, facing and adhesive shall have a composite rating:
      a. 25 flame spread maximum.
      b. 50 smoke developed maximum.
      c. In accordance with NFPA 255.
   3. Fire barrier shall have the following ratings:
      a. 0 flame spread maximum.
      b. 0 smoke developed maximum.
      c. In accordance with ASTM E84.

1.6 DELIVERY, STORAGE AND HANDLING

A. Materials shall be delivered in original, unbroken, brand marked containers.

B. Handle and store materials in a dry place in a manner which will prevent deterioration and contamination with foreign matter.

C. Reject damaged, deteriorated, contaminated material, or showing evidence of moisture, and immediately remove from the Site. Replace removed materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Thermal Insulation:
   1. Owens-Corning.
   2. Johns Manville.
   3. Armacell.
   5. Rubatex.

B. Adhesives:
   1. Benjamin-Foster.
   2. Baldwin-Ehret-Hill.
   3. Armstrong.

2.2 MATERIALS

A. Flexible Duct Wrap (F):
   1. Glass fiber blanket, factory-laminated to vapor barrier facing.
   2. Density: 1.0 lbs/cu ft.
   3. Thickness: As scheduled.
   4. Thermal Conductivity (k): 0.30 at 75 degrees mean.
   5. Facing: FSK.
   6. Owens-Corning, Type 75; or equal.

2.3 MECHANICAL FASTENERS

A. Impale Anchor:
   1. 12-gage galvanized steel.
   2. With self-adhesive pad.
   3. 2-inch speed washer.
2.4 ADHESIVES

A. Insulation-Adhesive and Tape: As recommended by Manufacturer of insulation.

B. Mastic: Benjamin-Foster, #60-15 C.I. Asphalitic coating or #3035 and #3800 General Purpose Vinyl-Acrylic coating; or equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean ductwork surfaces prior to applying insulation.

3.2 INSTALLATION

A. Follow insulation Manufacturer's recommended procedures.

B. Install in areas in pedestrian traffic areas where the bottom of piping is at an elevation less then 6'-8" above finished floor.

C. Thermal Insulation:
   1. Flexible wrap insulation shall be attached with 4-inch wide strips of insulation bonding adhesive spaced at 8 inches center-to-center. Adhesive shall be applied over entire surface of ductwork conveying or subjected to unconditioned outside air.
   2. Mechanical fasteners shall also be used on the underside of rectangular ductwork runs wider than 24 inches. Fastener spacing in accordance with A. above.
   3. Allow maximum fullness at corners when using flexible wrap.
   4. Provide removable section of insulation with a protected edge over access doors and around damper operators to allow operation without damage to insulation.

D. Joints and Sealants:
   1. Joints shall be tightly butted and sealed with 3-inch (minimum) foil reinforced kraft tape. Fastener penetrations and any other punctures in the vapor barrier facing shall also be taped and sealed with vapor barrier adhesive.
   2. Flexible wrap insulation joints shall be made with a 2-inch overlap of the vapor barrier secured with 9/16-inch outward clinching staples spaced 6 inches center-to-center.
   3. Taped joints at patches on rigid insulation shall be burnished or ironed on to ensure a tight seal.
   4. Use double tape strips when joining faced with unfaced insulation.

E. Damper Handles:
   1. Seal all exposed edges of insulation around handles.
   2. Tie a 2-foot long piece of bright orange ribbon on handle so it hangs down allowing easier visual locating of dampers.

3.3 APPLICATION SCHEDULE

A. Insulation Material Type:

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>Rigid fiberglass board</td>
</tr>
<tr>
<td>S</td>
<td>Semi-rigid fiberglass board</td>
</tr>
<tr>
<td>F</td>
<td>Flexible duct wrap</td>
</tr>
<tr>
<td>F-HD</td>
<td>High density flexible duct wrap</td>
</tr>
<tr>
<td>E</td>
<td>Flexible elastomeric sheet</td>
</tr>
<tr>
<td>L</td>
<td>Internal liner – Refer to Division 23 Section “Sound and Vibration Control for HVAC” for requirements</td>
</tr>
<tr>
<td>FB</td>
<td>Fire barrier</td>
</tr>
</tbody>
</table>
B. Covering (Refer to Part 2, Paragraph 2.3, of this Specification Section):

A = Aluminum jacket
P = Paint in accordance with Division 09 Section "Interior Painting"
PVC = Polyvinyl chloride jacket

C. Flanged Ductwork: Insulation thickness indicated in following tables shall be increased to be at least a 1/2-inch thicker than the flange depth.

D. Coordination of Insulation:
1. Requirements for internal liner for sound control are in addition to other requirements above. However, thickness requirements for external insulation may be reduced by up to 1-1/2-inch when duct liner is used.
2. Refer to Division 23 Section “Sound and Vibration Control for HVAC” for acoustic duct liner requirements.

E. Coordination of Insulation:
1. Requirements for internal liner for sound control are in addition to other requirements above. However, thickness requirements for external insulation may be reduced by up to 1-1/2-inch when duct liner is used.
2. Refer to Division 23 Section “Sound and Vibration Control for HVAC” for acoustic duct liner requirements.

F. Definitions:
1. Concealed: A space concealed from view or otherwise accessible only through the removal of ceiling tiles, access panels, or building construction components.
2. Exposed: Not concealed.
3. Plenum: A ceiling plenum or other concealed space used to transport air.
4. Heated Space: A space with a direct supply of heating.
5. Warm Space: A space within the building thermal barrier and also within the building vapor barrier but not having a direct supply of heating.
6. Unheated Space: A space within the building but outside of either the building thermal barrier or the building vapor barrier.
7. Cooled Space: A space with a direct supply of cooling.
8. Outside Air and Mixed Air: Unconditioned outside air, partial outside air, or relief or exhaust air downstream of last damper and subjected to unconditioned outside air.

G. Supply and Return Air:
1. Concealed:
   b. In Heated or Warm Space:
      1) Heating and Cooling Supply Air: Type F, 2-inch.
      2) Return Air and Heating Only Supply Air: Type F, 2-inch.
   c. In Unheated Space: Type F, 2-inch.

H. Internal Duct Liner:
1. Where indicated on Drawings, Contractor will use internal acoustic duct liner (Type L) of same thickness as specified above, in lieu of insulation specified above. Covering is not required.
2. Where internal acoustic duct liner is specified in Division 23 Section "Sound and Vibration Control for HVAC" for sound control, the specified external insulation thickness specified above may be reduced by up to 1-1/2-inch.
3.
4. Refer to Division 23 Section “Sound and Vibration Control for HVAC” for acoustic duct liner requirements.

END OF SECTION 23 07 13
SECTION 23 07 19 – HVAC PIPING INSULATION

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 furnishing and installation of piping insulation.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ASTM Specifications: C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

1.4 SUBMITTALS

A. Manufacturer's Literature: For piping insulation.
   1. For Each Type Used:
      a. Name of Manufacturer.
      b. Details of construction and installation.
      c. Manufacturer's data (density, K-factor).
   2. For Each Application:
      a. Thickness.
      b. Total "R" value.
      c. Jacket material.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable. Handle and store materials in a manner which will prevent deterioration and contamination with foreign matter.

B. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace removed materials at no additional cost to Owner.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Insulation:
   1. Pittsburgh-Corning.
   2. Owens-Corning.
   3. Certainteed.
   4. Armacell.
   5. Rubatex.

B. Jacketing (Aluminum or PVC):
   1. Ceel-Co.
   2. O'Brien.
   5. Pabco.

C. Adhesives:
   1. Benjamin Foster.
   2. Childers.
   3. Vimasco.
   4. B.E.H.
   5. Or equal.

2.2 TYPES OF INSULATION MATERIALS

A. Rigid Molded Glass Fiber – General (FG):
   1. All-service jacket (ASJ) type factory applied jacketing.
   2. 3 lbs/cu ft minimum density.
   3. k factor of 0.23 at 75 degrees F mean.
   4. 50 degree F service temperature.
   5. Owens-Corning Type ASJ Max Pipe Insulation with SSL Max closure system; or equal.
   6. Typical for application on pipes 16 inches and up.

B. Mineral-Fiber Insulation (MF):
   1. Preformed Pipe Insulation:
      a. Type I, 850 Degrees F (454 Degrees C) Materials:
         1) Mineral or glass fibers bonded with a thermosetting resin.
         2) Comply with ASTM C547, Type I, Grade A, without factory applied jacket.
      b. Johns Manville "Micro-Lok;" or equal.
   2. Pipe and Tank Insulation:
      a. Mineral or glass fibers bonded with a thermosetting resin.
      b. Semirigid board material complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB.
      c. Nominal density is 2.5 lb./cu. ft. (40 kg/cu. M) or more.
      d. Thermal conductivity (k-value) at 100 degrees F (55 degrees C) is 0.29 BTU x in./h x sq. ft. x degrees F (0.042 W/m x K) or less.
      e. Johns Manville; MicroFlex; or equal.

2.3 INSULATION INSERTS

A. Insulation inserts shall be made of calcium silicate treated with water repellant.

B. Inserts shall be preformed for the pipe size, same thickness as adjoining pipe insulation, same length as shield, and 180 degree-minimum segments.
C. Insulation inserts shall not be less than the following lengths:
   1. 2-1/2-Inch Pipe Size and Less: 10 inches long.

2.4 ACCESSORIES

A. Adhesives.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install piping insulation:
      a. In conformance with the Drawings, these Specifications, and the Manufacturer's recommendations.
      b. Over clean, dry piping system.
      c. To the following thickness:
         1) As specified herein or as indicated on the Drawings.
         2) If not specified herein or indicated on the Drawings, in accordance with Manufacturer's recommendations for the specific application.
      d. Continuous through walls, ceilings and sleeves except at fire stops.
      e. In areas in pedestrian traffic areas where the bottom of piping is at an elevation less than 6'-8" above finished floor.
   2. Fill all cracks and voids with insulating cement carefully troweled to leave a smooth finish.
   3. Repair or replace insulation damaged by:
      a. Demolition.
      b. Making connections to piping or equipment.
      c. Water or mildew.
   4. Insulate bundles of pipes out-of-doors with complete wrap of insulation 1-1/2 inches thick and of suitable diameter to contain bundle, with outer wrap.
   5. Verify that piping has been tested and cycled before applying insulation materials.
   6. All sectional pipe covering shall be neatly and tightly applied with unbroken lengths and with the ends of the sections firmly butted together. Longitudinal joints shall be on the least conspicuous side of the pipe and slightly staggered. Fiberglass cloth or other coating shall be lapped over all joints and well pasted or cemented down in a neat and inconspicuous manner.
   7. The insulation on piping shall be extended through all sleeves, anchor points and supports in order to produce a continuous application, and same shall be installed to conform to a uniform diameter.
   8. All fittings, flanges, end caps, etc. on all lines, except where otherwise noted, shall be covered with insulated fitting covers. Thickness of insulation, jackets and finishes shall also match adjacent piping.
   10. Insulation for piping shall be continuous through hangers and supports.
   11. Provide insulation inserts and insulation protection shields at hanger or support locations.
   12. Valve bodies to the bonnet flange or union, drip legs, and pipes at anchor points shall be insulated. Terminate insulation into a finished end.
   13. Terminate insulation into a finished end.
   14. Provide aluminum jacketing on all insulated piping for steam utility distribution.

B. Joints and Fittings:
   1. Block insulate valves and flanges with reusable insulation system.
   2. Insulate elbows, tube turns, sweeps and bends with mitered sections or premolded fittings. Match pipe covering material where used.
   3. Fit joints tightly together.
   4. Seal joints with sealing compound and preformed aluminum bands.
3.2 JACKETS AND FINISH

A. General:
1. Provide moisture barrier between the insulation and the jacketing in a continuous, unbroken seal.
2. Hold jacketing in place by a continuous sealed joint, providing a positive weatherproof seal along the entire length of the jacket.
3. Cap off ends with caps.
4. On cold lines, cut caps to the exact size of the pipe and seal with a recommended silicone calking.
5. Provide slip joints a minimum of every 25 feet or as needed for expansion.
6. Locate longitudinal jacket seams on indoor exposed piping out of view.

B. Attachment:
1. For systems operating at 50 degrees F and above: May be stapled using outward clinch staples spaced 3 inches apart at least 1/4-inch from the lap edge.

C. Taper and seal insulation ends regardless of service.

D. Fitting and pipe jackets to have matching finishes ready for painting.

E. For Insulation Without Factory Applied Jacket:
1. Finish with 8-ounce glass mesh and mastic.
2. Use breather mastic on piping operating at temperatures greater than 50 degrees F.

3.3 PIPING INSULATION APPLICATION SCHEDULE

A. Basis of Thickness Chart:
1. Thicknesses shown are based on products having a maximum "k" factor of 0.26 at a mean temperature of 75 degrees F.
2. These Thicknesses:
   a. Can be reduced for products having significantly lower "k" values.
   b. Shall be increased for products having higher "k" values in order to produce equivalent or greater thermal resistance.

B. Flame/Smoke Ratings: Local requirements for flame and smoke ratings must be met and may exclude some options listed herein.

C. Thickness Chart (In Inches):
1. Key: Insulation Type (Refer to Paragraph 2.2 of this Section):
   a. FG = Rigid Fiberglass.
   b. MF = Mineral Fiber.

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>Piping Systems Type</th>
<th>Temp (F) Range</th>
<th>Less Than 1&quot;</th>
<th>1&quot; to 1-1/4&quot;</th>
<th>1-1/2&quot; to 3&quot;</th>
<th>4&quot; to 6&quot;</th>
<th>8&quot; &amp; Up</th>
<th>Type of Insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Heating Water</td>
<td>180-250</td>
<td>1.5</td>
<td>1.5</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>FG, MF</td>
</tr>
</tbody>
</table>

* See PART 2 – PRODUCTS Article 2.2 TYPES for types of insulation.

END OF SECTION 23 07 19
SECTION 23 09 00 – INSTRUMENTATION AND CONTROL 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 the design, furnishing and installation of HVAC instrumentation and controls (HI&C) systems:

1. The Work of this Section also includes the integration of the Work of other trades as necessary to provide a complete operational control system as defined in the Contract Documents.

B. Major items unique to the work of this Section:

1. Direct digital control (DDC) hardware.
2. DDC software.
3. All remote sensing devices and interconnecting wiring or tubing.
4. All secondary control devices including, but not necessarily limited to, the following:
   a. Thermostats.
   b. Temperature and humidity sensors.
   c. Primary and secondary controllers.
   d. Automatic valves and dampers.
   e. Damper and valve operators.
   f. Relays.
   g. Operator interface.
   h. Network devices.
   i. Miscellaneous sensors.
5. Electric power supply source.
6. Conductor and conduit.
7. Necessary appurtenances to make a complete and functional system to satisfy the functional intent.
8. Final and complete operational demonstration.
9. Mechanical testing, adjusting and balancing.
10. BMS interface, integration devices and programming.

C. Mechanical systems included in the Work of this Section:

1. Except as specifically described below, it is the work of this Section to provide, install and integrate complete control of the HVAC systems, including, but not limited to the following:
   a. Heating hot water pump VFD operation and control.
   b. Air handling unit controls.
   c. Terminal unit controls.
   d. Ventilation system controls.

D. Integration:

1. Provide communication interface and network integration for the following packaged control systems furnished under the Work of other Sections:
   a. Package rooftop units as specified in Division 23 Section “Packaged, Outdoor Heating and Cooling Units.”
   b. Variable air volume boxes as specified in Division 23 Section “Air Terminal Units.”
   c. Smoke detectors in ductwork and air handling units.
2. Existing Control Equipment:
   a. Provide for interface between new controls installation and Owner’s existing control and building management systems:
      1) As indicated on the Drawings.
      2) As required to satisfy the functional intent description of this Section.
   b. All existing equipment is assumed to be fully functional and in proper working order as it relates to the work of this Section for Base Bid.
1.3 DIVISION OF WORK

A. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.

B. The following are suggestions as to how the Work may be divided. This is not intended to be a complete list of all the Work:

1. Mechanical Subcontractor:
   a. Install automatic valves and separable wells that are specified to be supplied by HI&C Subcontractor.
   b. Provide all necessary valved pressure taps, steam, water drain and overflow connections and piping.
   c. Provide all necessary piping connections required for flow devices, valve position indicators, flow switches, etc.
   d. Install all automatic dampers unless furnished as a factory mounted item with HVAC equipment.
   e. Provide all necessary blank-off plates (safing) required to install dampers that are smaller than duct size.
   f. Assemble multiple section dampers with the required interconnecting linkages and extend required number of shafts through ductwork for external mounting of damper motors.
   g. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation and seal permanently in place only after all stratification problems have been eliminated.
   h. Provide access doors or other approved means of access through ducts for service to control equipment.
   i. Mount duct smoke detectors.

2. Electrical Subcontractor:
   a. Provide conduit, conductors, and wire for all 120 volt or higher devices which interlock equipment provided under Division 23 with equipment and devices provided under other Divisions of the Specifications as indicated on Electrical Drawings and Division 26 Specifications.
   b. Termination by HI&C Subcontractor.
   c. Provide devices, conduit and wiring as indicated on Electrical Drawings.

3. HI&C Subcontractor:
   a. Be responsible for controls systems operation in accordance with sequence of operations description defined in Division 23 Section “Sequences of Operation for HVAC.”
   b. Furnish all automatic dampers, valves, operators and linkages.
   c. Provide a detailed schedule for the Mechanical Subcontractor of all automatic dampers and valves requiring their assembly or installation as suggested above.
   d. Provide 120 volt and low voltage power to all valve/damper motors requiring same.
   e. Wire all 120 volt flow, pressure and temperature sensing devices.
   f. Coordinate with Electrical Subcontractor for smoke detector interface compatibility and functional intent.
   g. Make final terminations to controlled components, including terminations from smoke detectors.
   h. Provide conductors and conduit, including low voltage and 120 volt, as required to provide functional intent, except as specifically indicated otherwise on Drawings or in the specifications.
   i. Provide all interface devices necessary for required communication to other systems.
   j. Provide for power supply for all DDC panels that are required that are in addition to those indicated on the Drawings.
   k. Operate all temperature control devices to confirm sequence of operations.

1.4 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the Work of this Section shall comply with the following:

1. ANSI - American National Standards Institute:
   b. ANSI X3.4 (ASCII).
2. EIA - Electronic Industry Association: EIA Standard RS-232-C.
3. NFPA – National Fire Protection Association:
   a. 70 – National Electrical Code.

1.5 DEFINITIONS

A. Where applicable, the terminology used herein uses the definitions listed in ASHRAE Standard 13.

B. Other definitions used include:
   1. Low Voltage:
      a. Voltage less than 120V single phase, typically 24V AC.
      b. Low voltage is used primarily for communication and control of devices.
   2. Large Valves: Valves for piping greater than 2 inches in diameter.
   3. Large Dampers: Greater than 133-inch/pound torque required or 30 square feet.
   4. DDC: Direct digital controls.
   5. IP: Internet protocol.
   6. LAN: Local area network.
   7. HVAC: Heating, ventilating and air conditioning systems. Generally, the work of Division 23.
   8. Primary Controller: A device that includes IP to field bus router, automatic time scheduling, trend logging, alarm handling, and supervisory logic control functionality. Sometimes referred to as a Building Controller.
   9. Secondary Controller:
      a. Advanced Application Controller: A controller with provisions and the control logic for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air-handling unit, chiller or boiler. An Advanced Application Controller may or may not have data management features such as time schedules, trend data storage and alarm message generation capabilities. These features may be provided by the Building Controller.
      b. Application Specific Device or Controller: A sensor, controller, or end device that is pre-programmed by the vendor. It may have physical inputs and physical outputs. The control logic, while not programmable, may be configurable through the use of configuration parameters. The application may require input network variables and may send output network variables onto the network.
   10. Control Logic Diagram: A graphical representation of control logic for the multiple processes that make up a system. Logic symbols are used to represent:
       a. Input/Output (I/O) data.
       b. Control functions such as PID, two-position control, switches, etc.
       c. Math functions such as addition, subtraction, multiplication, division, etc.
       d. Boolean functions such as greater than, less than, equal to, etc.
       e. Limit functions such as maximum, minimum, ramps, etc.
   11. Enterprise Level Data Manager (ELDM): A logic only device (controller without I/O) that is installed on the building LAN as the first node beneath the IP router. This device shall be programmable and be from the same Manufacturer that provides the enterprise level server and operator workstation software. The enterprise level data manager may be multiple identical devices installed on the building LAN in series in order to have sufficient capacity to support the building level controls. The enterprise level data manager may be combined in a single device with the IP router. The enterprise data manager serves 3 functions:
       a. Time Schedules: Time schedule algorithms shall reside in the enterprise level data manager. Occupancy/energize commands shall be broadcast to the building level controllers in the number required by the sequence of control.
       b. Trend Data Storage: The enterprise level data manager shall collect data from the building level controls at specified intervals and store the data for periodic uploading to the server. Polling communication techniques are acceptable for data collection by the data manager.
       c. Alarm Generation: The enterprise level data manager shall receive binary alarm variables from the building level controllers and transmit this data to the alarm handling software module within the server and operator work stations. Receipt of alarm data from the building level controls shall be based on broadcasting from the building level controls and not based on polling by the enterprise level data manager.
   12. JACE: Java Control Engine. A term used within the Niagara Framework to describe a enterprise level data manager:
13. Managed Communication: The transmission of data from a controller to a data manager, which in turn rebroadcasts the data to a second controller. The data manager may be referred to a network controller.

14. Peer to Peer Communication: Data is broadcast from its origin and is received by the final device requiring the data without being received and retransmitted by a third device.

15. Standalone Controller: A standalone controller has provisions for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air handling unit, chiller or boiler. The controller shall also have embedded in it all of the control logic that associated the physical inputs to the physical outputs. A standalone controller will also have data management features such as time schedules, trend data storage and alarm message generation capabilities.


17. Web Server: A software package installed on a primary/secondary controller or ELDM that provides for operation access to the Enterprise Level system from a computer on the LAN, using only a browser.

1.6 DESIGN AND PERFORMANCE REQUIREMENTS

A. System layout and design responsibility are included as Work of this Section:
1. Details of construction, quantities, components and accessories indicated on the Drawings and in the Specifications are minimum requirements.
2. Increases in system component requirements beyond these minimums that are determined by the system designer to be necessary to provide the functional intent and for a complete system shall not be a basis for an increase in cost to Owner. Refer to Division 23 Section “Sequences of Operation for HVAC” for functional intent.
3. Input/Output Summary Table: Refer to the Input/Output Summary Table at the end of this Section for a listing of the minimum points required for monitoring and functional intent. All additional points necessary for the functional intent, whether listed or not, are part of this Work.

B. Comply with the following performance requirements:
1. Graphic Display: Display graphic with minimum 20 dynamic points or as required to display required data.
2. Graphic Refresh: Update graphic with display with current data within 8 seconds.
3. Object Command: Reaction time of less than 2 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 6 seconds.
5. Alarm Response Time: Annunci ate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within 5 seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as 5 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: ±1 degree F (0.5 degree C).
   b. Water Flow: ±5% of full scale.
   c. Water Pressure: ±2% of full scale.
   d. Space Temperature: ±1 degree F (0.5 degree C).
   e. Ducted Air Temperature: ±1 degree F (0.5 degree C).
   f. Outside Air Temperature: ±2 degree F (1.0 degree C).
   g. Temperature Differential: Plus or minus 0.25 degree F (0.15 degree C).
   h. Relative Humidity: ± 5% [ 5 ][ 2 ]%
   i. Airflow (Terminal): ±10% of full scale.
   j. Air Pressure (Space): ±0.01-inch wg (2.5 Pa).
   k. Air Pressure (Ducts): ±0.1-inch wg (25 Pa).
   l. Carbon Dioxide: ±50 ppm.
   m. Electrical: ±5% of reading.
1.7 SUBMITTALS

A. Submit the following in accordance with Division 01 Section “Submittal Procedures.”

B. Submittals Prior to Construction:
   1. A description of the complete system, including a schematic diagram showing system architecture and all major components, cabinets, panels, sensors, controllers, hubs and operated devices, and required cabling between each.
      a. Include any environmental and space requirements for equipment.
      b. Anticipated deviations from performance and response time specified.
      c. A layout drawing indicating locations of controllers and major devices.
   2. Sensors, Controllers, Actuators and Related Devices:
      a. Complete system wiring diagrams and/or piping schematic including motor starters.
      b. Specification sheets on all individual control system components, including rated accuracy of sensors.
      c. Schedule of valves and dampers including size and performance characteristics.
   3. Complete Descriptions of Operation:
      a. Written sequences for software and hard-wired controls.
      b. 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 operator work station (OWS) shall be annotated with (adj) after the name of the parameter. This shall include setpoints, reset schedule parameters, calibration offsets, timer settings, control loop parameters such as gain, integral time constant, sample rates, differentials, etc.
         6) Within the sequence of control, all calculated values that are to be viewable at the OWS shall be annotated with (rpt) after the name.
         7) All points that shall be subject to manual control from an operator workstation.
         8) A list of all alarm points, a description of the alarm and a description of the alarm criteria.
         9) A list of all variables for which historical trending will be applied, the sample rates and any criteria used to start and stop the historical trending.
   4. Wiring diagrams.
   5. System Schematics: Include systems furnished by others that are integrated into the DDC system.
   6. Logic Schematics:
      a. Provide for each system and subsystem a complete logic schematic indicating all inputs, outputs, decisions, etc.
      b. Provide schematic format which includes all of the elements defined above.
      c. Provide a legend for all symbols used.
   7. Information of a general, non-project specific nature is not acceptable.
   8. Start-up Testing Plan: Submit a start-up testing plan for each unique system.
      a. The purpose of a start-up test is to demonstrate the “completeness” of the physical tasks associated with installation and the physical performance of the components.

C. Submittals After Construction:
      a. Start-up testing reports shall be submitted on a per system basis.
      b. Start-up testing reports shall be the documented results of the executed start-up testing plans.
   2. Operating and Maintenance Instructions: For all system components requiring maintenance include all maintenance information as required in Division 1 Section “Submittal Procedures” in addition to the following:
      a. Descriptive System Information: Include system logic schematics, input/output functions and Sequences of Operation.
      b. Operating Instructions: Include schedules and procedures for starting, stopping, cleaning, protection, testing, adjustments, calibration and replacement of components.
3. As-Built Documentation:
   a. Upon completion of the installation, and prior to acceptance by the Owner's representative, HI&C Contractor shall furnish as-built documentation and should include, but is not limited to the following:
      1) Points list in accordance with processor.
      2) Process flow diagram.
      3) Location plans.
      4) Operating sequences.
   b. All changes to the above submitted drawings, equipment descriptions and operation manuals shall be clearly identified on the as-built documentation.

4. 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. All software revisions shall be as installed at the time of the system acceptance.

5. 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.
      1) 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.
   b. Submit a copy of all application files that were created during the execution of the project.
   c. Submit a copy of all graphic page files created during the execution of the project.
   d. Submit a copy of all secondary graphic files such as bitmaps, jpegs, etc. that were used in the creation of the graphic pages.

1.8 QUALITY ASSURANCE

A. Fabrication, Programming and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.
   3. 3 years minimum experience in the design and installation of HI&C work similar to that specified herein.

B. Pre-Approved Installers: The following organizations are acceptable and are considered to meet the qualification requirements of this project:

C. Regulatory Agencies Requirements:
   1. All temperature control wiring shall comply with NEC.
   2. All smoke detectors shall bear the UL label and be FM approved.
   3. All components used for smoke control shall comply with UL864.
   4. All DDC I/O Devices (Specified and Future):
      b. Furnished with EIA (Electronic Industries Association) interface hardware.
   5. All instrumentation hardware shall be ISA (Instrument Society of America) compatible.
   6. All primary components of DDC hardware shall be UL listed (UL916).
   7. Installation shall comply with FCC (Federal Communications Commission) rules for Class A and Class B computing devices pursuant to Subpart J of Part 15.
   8. ASHRAE Standard 135, BACnet/IP.
   9. Network wiring shall comply with EIA/TIA Standards.

1.9 WARRANTY

A. In addition to the warranty provisions defined in the General Conditions, provide an extended warranty of a minimum 1 additional year (2 years total).
1.10 SERVICE AGREEMENT

A. Provide 12-month service and maintenance contract paid in full:
   1. Within 30 days after Substantial Completion.
   2. Signed by Manufacturer's authorized representative.

B. Programming and Setpoint Adjustments:
   1. In addition to service and maintenance, include 20 hours for adjustments in setpoints, reset schedules, and sequence revisions as directed by the Owner to "fine tune" control systems to building and occupant characteristics through 1 year of seasonal changes under full operation.
   2. Documentation:
      a. Submit documentation of actual time spent for programming and setpoint adjustments within 30 days after completion of the work for approval by Owner or Engineer.
      b. Time spent for service and maintenance as included above is not part of this allotment and is to be documented separately.

1.11 OWNERSHIP OF PROPRIETARY MATERIAL

A. The Owner shall retain all rights to software for this project.

B. The Owner shall sign a copy of the Manufacturer's standard software and firmware licensing agreement as a condition of this Contract. 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 servicing or altering the system in the future. Use of the software by individuals under contract to the Owner shall be restricted to use only for the purpose of servicing or altering the installed system.

D. All 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.
   9. Graphic symbol libraries.
   10. All documentation.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. General:
   1. Provide a micro-processor based logic system using low voltage electricity as a communication medium with an open architecture and distributed intelligence.
   2. All controlled components, sensors and controllers shall be addressable except:
      a. Terminal heating units such as unit heaters, cabinet heaters, convectors, finned tube.
      b. Ventilation fan and damper systems serving a single room and moving 1,000 cfm or less.
      c. Variable air volume (VAV) boxes.
   3. Pneumatic operators may be used on large valves and dampers.
   4. Provide completely computerized system using low voltage electricity as the operating medium.
   5. System Functions:
      a. Digital operation in accordance with preprogrammed strategies to control temperatures, energy use and selected electrical/mechanical equipment.
b. Capable of mathematical computation and logical/relational functions as required to achieve specified control strategies.
c. Capable of off-loading programs and accumulated data to magnetic media and a web browser.
d. Provide battery-powered RAM devices for program storage.
e. Continuous self-checking capability.
f. English language message display for all alarm and fault conditions.

B. Interoperability:
1. The system specified herein is a peer-to-peer addressable, standalone distributed control system integrating ANSI/ASHRAE Standard 135 (BACnet) technology and communication protocols in a common interoperable system. The system shall allow future expansion and modifications to the system with complete addressability without the use of proprietary components or software.
2. All software and intelligent devices shall comply with BACnet standards to provide complete interoperability between all system components.
   a. Each BACnet device shall be furnished with a protocol information conformance statement (PICS) certifying compliance to a minimum of Level 3.
3. System shall provide complete password-protected accessibility to all devices, controllers and data using Java enabled web browsers without the requirement for proprietary software.

C. System Architecture:
1. The system architecture shall consist of 2 layers, the LAN layer and the field bus layer.
2. The TCP/IP layer connects all of the buildings on a single-wide area network (WAN) isolated behind the Owner’s firewall. Fixed IP addresses for connections to the Owner’s WAN shall be used for each device that connects to the WAN.
3. The IP architecture shall operate over multiple IT subnets.
4. Where multiple IT subnets are involved, a BACnet Broadcast Management Device (BBMD) shall be part of the system architecture within each IP subnet. The BBMD functionality shall be in a stand alone device or integral with a BACnet Building Controller.
5. The system architecture shall include a BACnet Building Controller (B-BC) to connect each field bus to the WAN.
6. Each field bus shall consist of multiple segments with no more than 125 total connected devices. Each segment shall be isolated from the other segments by a repeater. Each segment shall have no more than 30 connected devices.

D. Networking:
1. All devices that connect to the LAN/WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
2. LAN/WAN To Field Bus Routing Devices:
   a. A BACnet Building Controller shall be used to provide this functionality.
   b. These devices shall be configurable locally with RS232 or IP crossover cable and configurable via the LAN/WAN.
   c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the LAN/WAN level of the architecture are to be forwarded.

2.2 MANUFACTURERS

A. Subject to compliance with interoperability requirements and these Specifications, hardware, software, and components shall be supplied by and bear the name of 1 or more of Manufacturers listed below. Alternate Manufacturers are also listed in this Specification for individual components.

B. Acceptable Manufacturers:
1. Siemens Building Technologies, Inc.

C. Stocking Requirements: All valves, operators, standard electrical components, and other replaceable parts shall be normally stocked within a 100 mile radius of the job Site.

D. Electrical Components: Provide electrical components as specified in Division 26 and as manufactured by the acceptable Manufacturers listed therein.
2.3 HARDWARE SYSTEM REQUIREMENTS

A. System Architecture:
1. Provide hardware comprised of a local building level primary controller and local control modules.
2. User programmable.
3. Provide Communication Networks:
   a. Local links for distributed programming, data interchange and control at all system levels.
   b. [Internal modem or] Web server for remote access through [local telephone or] Internet lines to all system functions and levels with firewall [and VPN hardware device].
4. Standalone capability for local control modules.
5. Analog Input:
   a. Analog sensing elements for remote indication to be independent of local sensors used for local control loops.
   b. The A/D conversion resolution shall not exceed 0.01 volts per count.
6. Binary Input:
   a. Air flow status for each fan shall be indicated by means of a differential pressure sensing device which opens an electrical contact as the differential pressure falls below an adjustable pressure range setting.
7. Output Control:
   a. Provide the necessary relays and wiring required to start and stop points, specified on the point list, through their respective existing control circuit.
   b. Wiring required to complement the following control functions:
      1) Auto: In the auto control, the existing control sequence is not changed.
      2) Close: In the close control, the controlled device is maintained in the fully closed position.

B. System Features:
1. Modular construction and interoperable protocol to ensure future expansion capability with interconnection of system modules.
2. Software configurable input and output points.
3. Expandable Point Capacity:
   a. At any point along the network without hardwiring points back to a central control panel.
   b. Provide a minimum of [6] [10%] spare outputs user configurable for digital or analog.
   c. System shall be modularly expandable to at least twice the installed capacity using additional hardware.

C. System Communication:
1. High Speed LAN and/or WAN Based, Arcnet or Ethernet Compatible: Capacity for a minimum of 2 operator stations, allowing concurrent multiuser, multitasking access to DDC network and control units.
2. Provide transparent peer-to-peer communication between all control panels.
3. Support an Internet communication link utilizing standard Internet protocol.
4. Provide Internet browser capabilities allowing transparent interfacing with all the functionality of the head end user station, using Java enabled web browsers without the use of proprietary software.

D. Operator Interface:
1. Provide fully programmable remote web based access capabilities allowing alarm management and setpoint and schedule adjustments.
   a. User interface shall be graphical in accordance with requirements below.
2. Building Level Processor:
   a. Run and print reports on specific equipment including AHUs, pumps, terminal units, boilers, etc.
   b. Monitor and edit equipment scheduling parameters.
   c. Receive and monitor alarms.
   d. Exchange data (read and edit) between all the various control panels.
   e. Receive and send data such that, from an off Site work station, all the functions listed under Items a, b, c, and d above, can be performed without the addition of new hardware or software.
3. At Local Control Modules:
   a. Peer-to-Peer Communications:
      1) Through an operator interface device, such as a laptop, hand held computer or touch pad
         screen, transparent interfacing to all other control panels shall be achieved such that it shall
         be as if being connected to the other control panel itself, without having to set up any
         separate communication services.
      2) Data, status information, reports, system software, custom programs, sensor data, etc., for
         all controllers shall be available for viewing and editing purposes.
   b. Any Manufacturer's HVAC equipment using BACNet control and communication protocol
      provided with it, could be installed and connected at any time to the control panel system and
      transparently provide all sequence of operation controlling points and alarms, as if it came with
      the central control system's brand name controls on it, without having to add additional equipment.
   c. Additional input and output points can be conveniently added via adding expansion modules.

4. Application Software (latest versions reside on microcomputer):
   a. Input/output capability from operator station.
   b. System access level via software password.
   c. Database creation and support.
   d. Dynamic color graphic displays.
   e. Alarm processing.
   f. Event processing.
   g. Data collection.
   h. Full building graphics development.
   i. Maintenance management.
   j. Control software.
   l. Trending applications.
   m. Control Manufacturer's internet website server link.

E. Primary Controller:
   1. Features:
      a. Building-level control system, with on-board storage of programs and data, and with monitoring
         capabilities over all points in the building system.
      b. Capable of standalone operation, supervising local control modules without a host computer.
      c. Built-in, password-protected, multi-function keypad/display providing complete access to building-
         level monitoring and control.
      d. RS-232-C port for connecting an optional ASCII terminal and/or printer to supplement the built-in
         keypad/display terminal.
      e. Equipped with multiple processors, battery backup of RAM, and a battery backed-up real time
         clock.
   2. Functions:
      a. Supervise all necessary building and energy management functions programs, including global
         data distribution (phase/power loss, outdoor temperature, external alarm status), time-of-day
         scheduling, holiday scheduling, optimized start/stop, duty cycle control, demand control, run time
         logging, equipment and system alarm monitoring, and self-diagnostics.
      b. Network of local control modules (up to 256 input/output control points).

F. Secondary Controller:
   1. General:
      a. Provide input/output, electronic thermostat, and terminal box controller modules as indicated on
         the Drawings and as required to satisfy the functional intent description of this Section.
      b. Microprocessor-based with on-board program storage.
      c. Capable of functioning as the input/output interface between the system and the
         building/equipment environment, providing control and management functions as programmed.
      d. Capable of built-in bi-directional communication capability, over 2-wire cable or Ethernet, with the
         Primary Processor for programming and reporting functions and for supervision of all control and
         energy management operations.
      e. Standalone capability to maintain programmed local control functions and operations including
         direct digital control in the event communications with the Primary Processor are lost.
      f. Equipped with timed override switches to allow programmed off-hours operation.
g. Provide with LED indicators or LCD display to show schedule status, output status and communication status.

2. Input/Output Modules:
   a. Capable of the following local control capabilities:
      1) Supervisory and closed loop control.
      2) Setpoint and setback control.
      3) Positioning control.
      4) Proportional reset.
      5) Status monitoring.
      6) Equipment alarms.
      7) Sequencing (staging).
   b. Local parameters and settings shall be monitorable and modifiable through the Primary Processor keypad/display terminal.
   c. Perform energy and building management functions under supervisory control from the Primary Processor.
   d. After initial communication with the Primary Processor, standalone programmed capabilities shall be stored on-board, in memory with 2,000 hour battery backup.
   e. Equipped with 8 inputs and 8 outputs which shall be software configurable as either analog, digital or pulsed digital.
   f. Configuration:
      1) Inputs and outputs shall be surge and spike protected.
      2) Inputs shall employ noise immunity circuits.
      3) Outputs shall employ noise suppression circuits.
      4) Outputs shall be equipped with internal manual/auto selection capability for local maintenance and troubleshooting use.
      5) Provide suitable intermediate devices where the load being controlled exceeds the rating of the output, or uses a different operating medium.

3. Electronic Thermostat Modules:
   a. Provide modules capable of the following:
      1) All necessary programmed functions.
      2) Energy and building management.
      3) Local control and monitoring.
   b. Features Required:
      1) Automatic downloading by Primary Processor.
      2) Standalone operation after initial Primary Processor communication.
      3) RAM memory storage for failsafe, fixed setpoint program items.
      4) Permanent ROM memory storage for failsafe, fixed setpoint program items.
   c. Local control functions include, but are not necessarily limited to:
      1) Cooling sequencing.
      2) Heating sequencing.
      3) Scheduling.
      4) Fan on/off.
      5) Mixed air damper modulation.
      6) Temperature setback.
      7) Optimized start and stop.
      8) Timed override.
   d. Provide for input device signal interface:
      1) Temperature Sensor: 4-20 mA.
      2) Air flow switch.
      3) Override pushbutton.

4. Terminal Box Controller Modules:
   a. Provide modules capable of the following:
      1) All necessary programmed functions.
      2) Energy and building management.
      3) Local control and monitoring.
      4) Integrating Primary Processor functions into local programs.
   b. Features Required:
      1) Automatic downloading by Primary Processor.
      2) Standalone operation after initial Primary Processor communication.
      3) RAM memory storage for failsafe, fixed setpoint program items.
4) Permanent ROM memory storage for failsafe, fixed setpoint program items.

c. Local control functions include, but are not necessarily limited to:
   1) Damper positioning.
   2) Fan start/stop.
   3) Reheat coil valve modulation.
   4) Temperature setback.
   5) Timed override.

d. Provide for input device signal interface:
   1) Temperature Sensor: 4-20 mA.
   2) Air flow switch.
   3) Override pushbutton.

G. Rooftop Unit Controls:
   1. Provide rooftop unit controller modules as indicated on the Drawings and as required to satisfy the functional intent description of this Section.
      a. Microprocessor based with on-board program storage.
      b. Capable of functioning as the input/output interface between the system and the building/equipment environment, providing control and management functions as programmed.
      c. Capable of built-in bi-directional communication capability, over 2-wire cable, with the Primary Processor for programming and reporting functions and for supervision of all control and energy management operations.
      d. Standalone capability to maintain programmed local control functions and operations including direct digital control, in the event communications with the Primary Processor are lost.
      e. Equipped with timed override switches to allow programmed off hours operation.
      f. The DDC system control panel shall be capable of communicating with each individual rooftop and monitoring various points. There shall be 1 controller per rooftop that communicates back to the main control panel.

   2. The RTU controller shall be capable of monitoring and communicating the following information back to the system control panel:
      a. Analog Input Points:
         1) Outdoor air temperature.
         2) Supply air temperature.
         3) Space air temperature.
         4) Return air temperature.
         5) Active setpoint.
         6) Outdoor air relative humidity (%).
         7) Outdoor air damper position.
         8) Return air damper position.
         9) Space carbon dioxide level.
      b. Binary Input Points:
         1) Smoke/fire alarm status.
         2) Heating status.
         3) Economizer enable/disable status.
         4) Coil enable/disable status.
         5) Supply fan on/off status.
         6) Supply fan failure.
         7) Exhaust fan on/off status.
         8) Exhaust fan failure.
         9) Cooling contactor status.

   3. The system control panel shall provide the following control functions for each RTU:
      a. Schedule all RTUs for heating night setback.
      b. Schedule all RTUs for a heating morning warm-up.
      c. Schedule night setup during cooling.
      d. Schedule all RTUs for optimum start and provide a program that automatically adjusts on a daily basis the morning start-up time based on the zone temperature versus the occupied setpoint and the historical recovery rate for each unit.

4. Remote Sensors:
   a. Air Temperature Sensor Quantity:
      1) See location detail on the Drawings.
   b. Each zone shall be provided with a temperature sensor.
c. Provide carbon dioxide sensors where shown on drawings.
d. Sensors shall provide input to the RTU controllers.
e. Sensors shall be located as indicated on the Drawings.

2.4 SOFTWARE SYSTEM FEATURES

A. The programmable energy and building management functions include, but are not necessarily limited to:

1. User Setpoint Control:
   a. Time of Day Scheduling:
      1) Capable of optimally starting based on individual unit recovery ramps.
      2) Time of day scheduling shall be continuous, such that if power is lost, on power up, the
         panel will look back for each device to see whether it should be on/off or in
         occupied/unoccupied temperature setpoints.
   b. Holiday and weekend schedules.
   c. Space temperature setpoint control.
   d. Space humidity setpoint control.
   e. Space ventilation setpoint control.
   f. Timed Override:
      1) Each scheduled device shall be able to be overridden at the operator work station and space
         sensor to the occupied mode for up to 4 hours.
      2) The override shall also be cancelable from the operator work station at any time during the
         override.

2. System Controller Features:
   a. Temperature reset.
   b. Economizer control (free cooling).
   c. Temperature control.
   d. Humidity control.
   e. Terminal box grouping.
   f. Power fail restart sequencing.
   g. PID loop control.
   h. Data logging.
   i. Duty cycling.
   j. Optimized start/stop.
   k. Demand limit control.
   l. Control to greatest demand, with the ability to ignore specific demand inputs.
   m. Event Log: The last 100 events shall be maintained for review at the OWS and remotely.
   n. Daylight Savings Time:
      1) The system panel software shall automatically update time according to daylight savings at
         the legislated time and date, and reset time at the end of the daylight savings period.
      2) This function shall be able to be disabled.

3. Control programs include, but are not necessarily limited to:
   a. Setpoint (closed loop).
   b. Proportional reset.
   c. Sequencing by time and/or temperature.
   d. Limit and status monitoring.
   e. Local emergency overrides.
   f. Local timed schedule overrides.
   g. Outdoor temperature operating limits.

4. Capable of combining functions as required for specific user requirements.

B. User and Programmer Access:
   1. User password protected.
   2. Programmer password protected.

C. Custom Programming:
   1. Provide a user-friendly, interactive, "on-line" programming language for the purpose of creating custom
      programs for specific, unique applications.
2. All custom programming must be performed in English language commands, and all inputs, outputs, variables and flags shall be addressable by user specific English names without requiring alphanumeric addresses or point numbers.

3. The system shall be programmable to allow or secure each of the above setpoint controls at each level.

4. Provide software graphic package, including graphical representations for all major systems.

D. Logs/Alarms:
1. Provide automatic logging of control alarms, critical alarms, kW demand history and kWh consumption.
2. Additional logging shall be programmable including, but not limited to:
   a. Equipment run time.
   b. Historic trends and logs.
   c. User defined meters.
   d. User access logs and point scans.
3. Provide alarm monitoring and reporting capabilities for all input points, including phase loss alarms, external alarms, load control alarms, critical alarms with auto-dial-up feature, alarm summary on printer, including time and date of alarm, and programmable power-failure restart sequence.

4. Audible Alarms:
   a. Provide audible alarm at building level processor for each alarm condition.
   b. Provide operator silencing. Reset daily.

5. At Control Panel Systems:
   a. Peer-To-Peer Communications:
      1) Through an operator interface device, such as a laptop, hand held computer or touch pad screen, transparent interfacing to all other control panels shall be achieved such that it shall be as if being connected to the other control panel itself, without having to set up any separate communication services.
      2) Data, status information, reports, system software, custom programs, sensor data, etc., for all controllers shall be available for viewing and editing purposes.
   b. Any Manufacturer’s HVAC equipment using BACNet control and communication protocol provided with it, could be installed and connected at any time to the control panel system and transparently provide all sequence of operation controlling points and alarms, as if it came with the central control system’s brand name controls on it, without having to add additional equipment.
   c. Additional input and output points can be conveniently added via adding expansion modules.
   d. Run and print trends of selected equipment performance characteristics in table and graph forms.
   e. Run and print reports on specific equipment including AHUs, pumps, terminal units, chillers, boilers, towers, etc.
   f. Monitor and edit equipment scheduling parameters.
   g. Receive and monitor alarms.
   h. Manage the network including monitoring of the loss of communication and clock setting functions.
   i. Exchange data (read and edit) between all the various control panels.
   j. Receive and send data such that from another control Manufacturer’s PC work station off Site from the primary head end, all the functions listed under Items a, b, c, d, e and f, above, can be performed without the addition of new hardware or software.

E. Program Descriptions:
1. Time-Of-Day Scheduling:
   a. Decrease energy consumption by turning off loads during unoccupied hours or unoccupied days.
   b. Programmable in 1 minute increments.
   c. Up to 64 discrete schedules in accordance with Primary Processor system.
   d. Up to 16 groups of loads (consisting of up to 16 loads each) for concurrent scheduling.
   e. Ability to assign loads to existing alternate schedules by linking.
   f. Timed overrides and temporary "today" and "tomorrow" schedules, for each schedule.

2. Setpoint/Setback Control:
   a. Decrease energy consumption by modifying space temperature setpoints during scheduled unoccupied hours, thereby reducing use of mechanical heating or cooling.
   b. Timed override off hours setpoint operation.

3. Optimized Start/Stop:
   a. Decrease energy consumption by learning building response to changing weather and automatically turning on HVAC as late as possible in the morning and off as early as possible in the evening, while meeting ambient temperature requirements during occupied hours.
   b. Optimized start and stop times updated daily.
4. Holiday Scheduling:
   a. Allow up to 16 holiday periods to be programmed.
   b. Each holiday period programmable for a maximum of 99 consecutive days.

5. Temperature Reset:
   a. Capable of user-defined linear proportional reset functions.
   b. Programmable reset parameters, variables and limits.
   c. Variables programmable as the highest, lowest or average of multiple inputs.

6. Economizer Control (Free Cooling):
   a. Reduce energy consumption by utilizing outside air for cooling:
      1) Enthalpy based.
      2) In lieu of mechanical cooling equipment.
   b. Programmable to operate fan systems during unoccupied hours of the cooling season in the maximum outside air mode.

7. Direct Digital Temperature Control:
   a. Maintain automatic temperature control directly by the local control module microprocessor.
   b. Local module capable of performing all necessary local control functions.

8. Terminal Box Grouping: The DDC shall be able to group VAV boxes via keyboard commands. These terminal unit groups shall make it possible to:
   a. Send a common command to all boxes in a group to operate in the same mode.
   b. Offset heating or cooling setpoints of 1 or more terminal unit groups by an adjustable amount.
   c. Receive and display information on a group basis, including, but not necessarily limited to:
      1) Minimum group temperature.
      2) Maximum group temperature.
      3) Average group temperature.
      4) Current airflow through boxes in group.

2.5 ELECTRICAL DEVICES AND WIRING

A. Comply with all local codes and applicable Sections in Division 26 of these Specifications.

B. Low Voltage Wiring (24V or Less):
   1. Installed in a ceiling plenum used for return air shall be plenum rated wire securely fastened in accordance with the requirements of Division 26.
   2. Exposed wiring shall be installed in accordance with the requirements of Division 26.

C. Approved Manufacturers:
   1. Honeywell.
   2. Siemens.
   3. Allen-Bradley.
   4. GE.
   5. Square D.

D. Limit Switches: Limit switches shall be oil tight type with appropriate operator to provide required function. Limit switches used on dampers should be set at approximately 75% of full stroke.

E. Control Relays and Contactors:
   1. Relays shall be a minimum DPDT, of proper coil voltage, with indicator light, and of sufficient rating for specified purpose. Relay base shall be of the screwed terminal type.
   2. Contactors shall be definite purpose type, have adequate number of poles, of proper coil voltage, and of sufficient rating for specified purpose.

F. Selector Switches:
   1. Switches shall be multiple position type, oil-tight, watertight, dust-tight, have the adequate number of contact blocks, capable of additional contact blocks, and of sufficient rating for specified purpose.
   2. Nomenclature plate shall be provided with appropriate wording, units, etc.
G. Push Buttons and Pilot Lights
1. Push button switches and pilot lights shall be, oil-tight, watertight, dust-tight, have the adequate number of contact blocks, capable of additional contact blocks, and of sufficient rating for specified purpose.
2. Nomenclature plate shall be provided with appropriate wording, units, etc.
3. Pilot lights shall be LED, push-to-test type with replaceable lamps and lens. Lens shall be of the appropriate color for application served.

H. Environment:
1. All devices shall be of the correct NEMA rating for the environment in which it is installed.
2. Refer to Electrical Drawings for area classifications.

2.6 ELECTRIC INSTRUMENTS

A. Thermistor Temperature Sensors and Transmitters:
1. Accuracy: ± 0.5 degrees F (0.3 degrees C) at calibration point.
2. Wire: Twisted, shielded pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sf (0.84 sq. m).
4. Averaging Elements in Ducts: 36 inches (915 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
   a. Setpoint Adjustment: Exposed.
   c. Thermometer: Exposed.
7. Outside Air Sensors: Watertight inlet fitting, shielded from direct sunlight. Provide vandal resistant enclosures where accessible to the public.

B. RTDs and Transmitters:
1. Accuracy: ±0.2% at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
4. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
5. Room Sensor Cover Construction: Manufacturer’s standard locking covers.
   a. Setpoint Adjustment: Exposed.
   c. Thermometer: Exposed.
6. Outside Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

C. Low Temperature Detection:
1. Provide Electric Thermostat:
   a. With 20-foot sensing element installed in a serpentine manner across the coil face area.
   b. 2-position manual reset type with adjustable differential and of range to match the application.
2. Provide multiple thermostats wired in series as required to provide complete coil area coverage.
3. Shut down the unit supply fan upon detection of a low temperature along any 1-foot length of its sensing element.

D. Static Pressure Transducer:
1. Factory installed and wired in the control box.
2. The transducer shall have a range of 0 to 5-inch W.G. and shall have an accuracy of ±2% of the range, including nonlinearity and hysteresis.
3. The static pressure probe shall be field installed 2/3 down the duct or as indicated on the Drawings.

E. Differential Air Pressure Switch:
1. The differential air pressure switch shall be factory installed across the supply fan inlet and discharge and field wired to the fan relay.
2. The switch shall be SPDT and shall include a manual reset button.
3. The switch shall be factory set at 3.0-inch W.G. and shall have the ability of being field adjusted over a range of 1.4-inch to 6.0-inch W.G.

F. Relative Humidity Transmitter:
   1. Polymer film capacitance change type.
   2. Temperature compensated.
   3. Accuracy: ± 2%.
   4. Range: 0 - 100% relative humidity.
   5. Ambient Temperature: 0 - 120 degrees F.
   6. Output Signal: 4 to 20 mA or 0 to 10 VDC, as required.
   7. Manufacturers:
      a. General Eastern Instruments Corporation.
      b. Vaisala, Inc.

G. Carbon Dioxide Sensor:
   1. Manufacturer and Model: Johnson Controls, CDS-2000-2; or approved equal.
   2. Description: Carbon dioxide sensor using non-dispersive infrared (NDIR) sensing technology to measure carbon dioxide and provide a 1-10 VDC output signal corresponding to 2-2000 parts per million (ppm) concentration of carbon dioxide.
   3. Components:
      a. Carbon dioxide sensor capable of measuring carbon dioxide concentration in air from 0-2000 ppm.
      b. 24V AC transformer to power carbon dioxide sensor.
      c. Supply air flow filter which inhibits sensing chamber contamination.
      d. 2 front-mount wiring terminals blocks.
   4. Performance Requirements:
      a. Accuracy: ±100 ppm carbon dioxide.
      b. Repeatability: ±20 ppm carbon dioxide.
      c. Drift: ±100 ppm carbon dioxide per year.
      d. Response Time: Less than, or equal to 30 seconds maximum.
      e. Airflow Rate: 500 milliliters per minute at 1.4 psi ±10% through 1/4-inch O.D. tubing.

2.7 GAGES

A. Comply with the requirements of Division 23 Section “Meters and Gages for HVAC Piping.”

B. Air Pressure Gages:
   1. Provide 1-1/2-inch diameter gages at all input sensor lines, switch lines, branch side of each controller and at each controlled device.
   2. Stem or surface mounted as required.
   3. Compatible with tubing size.

C. Temperature, Humidity and Pressure Indicators:
   1. Dial type having a minimum diameter of 3-1/2 inches, adjustable calibration, and accuracy of ±1/4% of dial range.
   2. Thermometer ranges to match the range of the transmitter with which used.
   3. Furnish for all transmitters as described in the Functional Intent article of this Section.

D. Alternate Manufacturers: As listed in Division 23 Section “Meters and Gages for HVAC Piping.”

2.8 AUTOMATIC CONTROL VALVES AND ACTUATORS

A. Furnish valves in accordance with the requirements of Division 23 Section “General Duty Valves for HVAC.”

B. Control Valve Actuators:
   1. Size to operate with sufficient reserve power to provide smooth modulating action or 2-position action.
   2. Close-off (differential) pressure rating.
3. Hydronic Systems: Combination of actuator and trim shall provide minimum close-off pressure rating of 150% of total system (pump) head for 2-way valves and 100% of pressure differential across valve or 100% of total system (pump) head.

4. Steam Systems: Combination of actuator and trim shall provide minimum close-off pressure rating of 150% of operating (inlet) pressure.

5. Provide with neck extension on insulated service

6. Pneumatic Valve Operators:
   a. Cast iron yoke with steel or cast aluminum bolted diaphragm enclosure.
   b. Buna N or Neoprene diaphragm designed for 30 psig maximum pressure.
   c. 3 to 14 psig input signal.
   d. Rolling neoprene diaphragm style, either normally open or normally closed as required.
   e. Pilot Positioner:
      1) Provide for:
         a) All valves 1-1/2 inches and larger.
         b) As required for proper sequencing.
         c) As indicated.
      2) Three-Pipe Relay Device With Position Indicator: 3 to 13 psig operating range.

7. Electric Actuators and Motors:
   a. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
      1) Johnson.
      2) Honeywell.
      3) Belimo Aircontrols (USA), Inc.
      4) Siemens.
   b. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   c. Serviceable and rebuildable.
   d. Coupling: V-bolt and V-shaped, toothed cradle.
   e. Overload Protection: Electronic overload or digital rotation-sensing circuitry.

2.9 INSTRUMENT TEST HOLES

A. Provide surface mounted, flanged test holes with removable caps and of sufficient length to extend beyond external duct insulation.

B. Install at all control points in ductwork, including, but not necessarily limited to:
   1. Discharge air controllers.
   2. Return air controllers.
   3. Mixed air controllers.
   4. Pressure sensors.
   5. Limit thermostats.
   6. Temperature sensors.

C. As manufactured by Ventfabrics, Inc.; Ventlock, Model 699; or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Electrical Wiring:
   1. Motor Starters:
      a. Provide independent control circuit to each motor starter contactor coil.
      b. Provide a normally open interlock contact in each motor starter to indicate contactor status at DDC.
      c. Provide one electrically separate, normally open contact to start or stop each motor controlled by the system.
2. Limit Interlocks:
   a. Wiring of limit interlocks and dampers shall include on-off-auto switch on speed controllers.
   b. Wiring of all limit interlocks shall be such that the equipment will be de-energized in all operating positions of the starter.
3. Provide separate branch circuits for all 120 VAC power serving DDC equipment and related components.

B. Outside Air Transmitters:
   1. Locate on a north exterior wall.
   2. Do not locate in fresh air ducts.

C. Duct Pressure Sensors:
   1. Locate and set duct static pressure sensors as indicated on the Drawings or as instructed by the Engineer.
   2. Allow for one relocation and one reset of each static pressure sensor as instructed by the Engineer at no additional cost to the Owner.

3.2 FIELD QUALITY CONTROL

A. Demonstration and Acceptance Test:
   1. Operate each and every phase of the control system separately, or in conjunction one with the other:
      a. For a sufficient period of time to demonstrate the ability of the system to meet performance requirements in accordance with the true intent and purpose of these Specifications.
      b. Provide for notification and approval of Engineer as required by Division 01 Section “Starting and Adjusting.”
   2. The HI&C Subcontractor is responsible for verifying and demonstrating that each Sequence of Operation is being performed and design conditions stably maintained under operating conditions.
   3. Acceptance of performance will be provided by the Owner.
   4. Provide 8 hours of field service time for demonstration and acceptance test. Additional costs required due to retesting due to failure of system to perform satisfactorily shall be the responsibility of HI&C Subcontractor.

B. Operator Instruction:
   1. When acceptable performance of the system hardware and software has been established, provide onsite operator instruction to Owner's operating personnel.
   2. Operator instruction during normal working hours shall be performed by competent Manufacturer's representative familiar with the software, hardware and accessories.
   3. At a time mutually agreed upon as stated above, provide 8 hours of instruction to Owner's designated personnel on the operation of all equipment within the system and describe its intended use with respect to the programmed functions specified.
   4. Includes, but is not necessarily limited to:
      a. The overall operational program, equipment functions (both individually and a part of the total integrated system).
      b. Commands.
      c. Advisories.
      d. The appropriate operator's intervention required in responding to the system's operation.
      e. A description of the chronological information flow from field sensors, contacts and devices to the centrally located control console.
      f. The overview of the system's communication network to acquaint the operator of the interplay between initiating devices, remote processing units, loop communications and their importance within the operating system.
   5. Provide additional information time, as deemed necessary by Owner's authorized representative, on a negotiated basis with Owner.

C. Troubleshooting: Comply with the requirements of Division 23 Section “General HVAC Provisions,” Article 1.7, for troubleshooting.
3.3 ADJUSTMENTS AND CALIBRATION

A. Upon completion of this Project, adjust and validate all thermostats, controllers, valves, damper operators, relays, and other components provided as part of the temperature control system.

B. Calibration:
   1. After completion of installation, the pneumatic piping shall be tested for leaks.
   2. Provide calibration documentation to Engineer, which shall include:
      a. Airflow transmitter calibration curves to relate the transmitter output signal to the actual airflow as well as to the pressure drop across the primary flow measuring element.
      b. For pressure, differential pressure, flow, and other transmitter's provide calibration curves using the zero, span and 3 other points between 10% and 90% of span. These curves shall relate the output signal of the transmitter to the primary measured value.
      c. Indicating instruments shall read true conditions and be checked with test instruments.
      d. Calibration of temperature and humidity sensors.

C. Adjustments, Tuning and Start-up:
   1. After the completion of calibration, adjust and tune the controls.
   2. Provide documentation, which is to include:
      a. Input/output relationship of all controllers, positioners, and final drive units.
      b. Gains and time constants established in all controllers.
      c. Loop setpoints.
      d. Limits on control actions.
      e. Alarm limits.
      f. Control dead bands.
   3. Provide seasonal adjustments as required under Article 1.10 - Service Agreement.

END OF SECTION 23 09 00
SECTION 23 10 23 – NATURAL GAS PIPING SYSTEM

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 furnishing and installation of natural gas piping and related items:
   1. Natural gas distribution system.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   2. ASME B31.1 - Power Piping.

1.4 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications: Trained and experienced in the fabrication and installation of the materials and equipment.

B. Installation shall comply with:
   1. State and local codes and ordinances.
   2. Requirements of:
      a. Owner’s insurer.
      b. Gas distribution utility.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration and contamination with foreign matter.

C. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace removed materials at no additional cost to Owner.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. During Freezing Weather:
   1. Protect all materials in such a manner that no harm can be done to:
      a. Installations already made.
      b. Materials and equipment on the Site.

F. Furnish all necessary protection for such installations and equipment as may be required.
PART 2 - PRODUCTS

2.1 PIPE AND FITTING APPLICATIONS:

A. General:
1. Comply with the requirements of Division 23 Section “Steel Pipe and Fittings for HVAC.”
2. Pipe 6'-0" and longer shall be permanently marked with the following information:
   a. Manufacturer’s name.
   b. Pressure rating.
   c. Size.
3. No field fabricated fittings allowed. Provide factory manufactured fittings.

B. Natural Gas – To 30 psig:
1. For Piping Through 2-Inch:
   a. Pipe: Black Steel, Schedule 40, ASTM A53 or A106, seamless, Grade B.
      2) Joints: Screwed.
2. For Piping 2-1/2-Inch and Larger:
   a. Pipe: Black Steel, Schedule 40, ASTM A53 or A106, seamless, Grade B.
      2) Joints: Welded. Flanged ASTM A181, 150 pound, forged steel at valves, and equipment.

2.2 VALVES

A. Plug Valves:
1. Aboveground:
   a. Plug valves (gas cock) for natural gas shutoff applications shall be lubricated type equal to
      Homestead Figure 611 or 612 or Rockwell Figure 114 or 115.
   b. Valves 2-inch and smaller shall be threaded. Valves 2-1/2-inch and larger shall be flanged.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
4. Corrugated stainless steel tubing with polymer coating.
5. Operating Pressure Rating: 0.5 psig.

2.4 PRESSURE REGULATORS

A. General Requirements:
1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion resistant components.
3. Elevation compensator.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Canadian Meter Company, Inc.
   b. Eaton Corporation; Controls Division.
   d. Maxitrol Company.
   e. SCP, Inc.
2. Body and Diaphragm Case: Die cast aluminum.
5. Seat Disc: Nitrile rubber.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 NATURAL GAS DISTRIBUTION SYSTEM

A. Description of Work:
1. Provide complete natural gas distribution system as indicated on Drawings and as required to comply with applicable codes and regulations (0.3 inches pressure drop).
2. This includes, but is not limited to, the following:
   a. Connect to gas meter installation.
   b. Vent lines to atmosphere where applicable.
   c. Connect gas to equipment outlets.
   d. Auxiliaries and accessories.

B. Aboveground and Indoor Piping and Installation:
1. Install gas piping and valves in accordance with the requirements of the International Fuel Gas Code, the gas company, and the NFPA 54 National Fuel Gas Code.
2. Run gas piping and make final connections to equipment requiring gas.
3. Install gasock and drip in branch laterals serving each piece of equipment.
4. Gas pipe in inaccessible locations shall not have unions, valves, tubing fittings or running threads.
5. 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.
6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Locate valves for easy access.
8. Install natural gas piping at uniform grade of 2% down toward drip and sediment traps.
9. Install piping free of sags and bends.
10. Verify final equipment locations for roughing-in.
11. Drips and Sediment Traps: Install drips at points where condensate may collect, including service meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
   a. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
12. Extend relief vent connections for service regulators, line regulators and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
13. Connect branch piping from top or side of horizontal piping.
14. Eccentric fittings or eccentric reducing couplings shall be used to make reductions. Install fittings with level side down.
15. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
16. Install strainer on inlet of each line pressure regulator and automatic or electrically operated valve.
17. Install pressure gage upstream and downstream from each line regulator.

C. Connections:
1. 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.
2. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

END OF SECTION 23 10 23
SECTION 23 20 19 – PIPING SPECIALTIES 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 the furnishing and installation of piping specialties.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ASTM Specifications:
      c. A193 - Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   2. ANSI Standards:
      b. B16.5 - Pipe Flanges and Flanged Fittings.
      c. B16.24 - Bronze Pipe Flanges and Flanged Fittings, Class 150 and 300.
   3. ASME American Society of Mechanical Engineers:
      a. Boiler and Pressure Vessel Code - Section II.
      c. B31.5 - Building Services Piping.

1.4 SUBMITTALS

A. Manufacturer's Literature: For all items listed in PART 2 – PRODUCTS. Include dimensions, details of construction and installation, name of Manufacturer, and model.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

PART 2 - PRODUCTS

2.1 STRAINERS

A. Manufacturer: Armstrong, Mueller.

B. Type: "Y".

C. Screen: 20 mesh brass, removable.

D. Area: 5 times pipe diameter.

E. Pressure Rating: Match piping.

F. Install in front of each modulating valve, steam trap, pressure regulating valve, pump suction and where indicated. Each strainer shall be equipped with a blow down valve and trap assembly, if on steam line.
2.2 MANUAL AIR VENTS

A. Manufacturer: Bell & Gossett or Dole.

B. Size: 1/8-inch.

C. Type: Slotted head (Bell & Gossett 4V or Dole No. 9).

D. Location:
   1. All cabinet, unit heaters and air handler, and coils.
   2. At all high points in the piping.
   3. Wherever called for on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all piping specialties in conformance with:
   1. The Shop Drawings reviewed by Engineer.
   2. The Manufacturer's recommendation.

B. Furnish and install all vibration isolators, flexible connections, expansion joints, expansion loops required to reduce noise transmissions and stress on equipment and piping.

C. Cold spring all piping installed with expansion loops half of the total expansion. This requirement does not reduce the amount of expansion compensation required of the loop or joint.

END OF SECTION 23 20 19
SECTION 23 21 13 – HYDRONIC 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 furnishing and installation of a hydronic piping and circulation system for heating hot water.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. American Society of Mechanical Engineering (ASME):
      b. B31.5 - Code for Building Services Piping.
      d. Heating Boiler Code.

1.4 SUBMITTALS

A. Manufacturer's Literature: For all products listed in Part 2.
   1. General:
      a. Dimensions.
      b. Details of construction and installation.
      c. Name of Manufacturer.
      d. Model number.
   2. Flow Measurement Devices:
      a. Flow and pressure drop curves.
      b. List each application with flow and size clearly indicated.

B. Operation and Maintenance Manuals: For all flow measurement devices.
   1. Equipment function, normal operating characteristics and limiting conditions.
   2. Assembly, installation, adjustment and checking instructions.
   4. Guide to "troubleshooting".
   5. Parts lists and predicted life of parts subject to wear.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

1.6 MAINTENANCE

A. Valve and Vent Schedule:
   1. Provide the following schedules:
      a. Air Vents: Indicate air vent number and location of all manual air vents that are not attached to a univent, heating unit, ventilating unit or other equipment.
      b. Valves: Indicate valve number, location and function of all valves.
   2. Mount schedules under plexiglass as directed by the Owner.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Except as otherwise indicated on the Drawings or specified herein, the manufactured units and flow measurement devices shall be supplied by one of the following:
   1. Bell & Gossett.
   2. Armstrong Pumps, Inc.
   3. Taco, Inc.
   5. Deiterich Standard Corp. (Flow Indicators).
   6. Amtrol (Expansion Tank).
   7. Nexus.
   8. Apollo.

2.2 MATERIALS

A. Piping: Comply with the requirements of Division 23 Section “Copper Pipe and Fittings for HVAC.”

2.3 MANUFACTURED UNITS

A. Strainer:
   1. ASME, 125 psi, 375 degrees F.
   2. Strainer Material: Galvanized.
   4. Free Area: 5 times pipe area.
   5. Blow Down Connection: Yes.

B. Shutoff Valves:
   1. 125 psi at 250 degrees F.
   2. Furnish with adjustable memory stop on all throttling applications.
   3. Comply with the requirements of Division 23 Section “General Duty Valves for HVAC.”
   4. 2-1/2-Inch and Larger:
      a. Butterfly unless indicated otherwise on the Drawings.
      b. Iron body.
      c. Bronze disc.
      d. Stainless steel shaft.
      e. Resilient seat material designed for temperatures up to 250 degrees F.
      f. Equal to Dezurik Fig. No. 632-L-D-RS66-1 with adjustable memory stop for all throttling applications.
   5. 2-Inch and Smaller:
      a. All bronze construction.
      b. Ball or Butterfly unless indicated otherwise on the Drawings.
      c. Characterized port ball valves for throttling valve applications.
      d. Equal to Milwaukee Model BB2FS or Conbraco Apollo 70-100 with adjustable stop lever for all throttling applications.

C. Triple-Duty Valve: Not acceptable for any application.

2.4 FLOW MEASUREMENT DEVICES

A. Size:
   1. Select size to provide design flow at mid-range of scale.
   2. Do not use pipe size as basis of selection.
B. Circuit Setter (Flow Rates 2 gpm and Above):
   1. Manufacturer and Model:
      a. Bell & Gossett Model CB calibrated balancing valve.
      b. Armstrong Model CBV circuit balancing valve.
      c. Taco Model CS circuit setter.
   2. Bronze body construction with integral brass ball or globe valve, differential pressure readout ports and threaded drain connection.
   3. Rated for 300 psig/250 degree F operating conditions.
   4. Readout ports include caps and internal check valves.
   5. Furnish with calibrated name plate and memory stop.
   6. Furnish 1 Model RO-2 readout kit.
   7. Not acceptable for use as shutoff/isolation valve.

C. Circuit Setter (Flow Rates Less Than 2 gpm):
   1. Manufacturer and Model: Armstrong Model APV Venturi with a throttling ball valve.
   2. Bronze body construction with integral brass ball valve, venturi flow element, and differential pressure readout ports.
   3. Rated for 300 psig/250 degree F operating conditions.
   4. Readout ports include caps and internal check valves.
   5. Furnish with memory stop.
   6. Furnish 1 readout kit.
   7. Not acceptable for use as shutoff/isolation valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install piping and circulation system in accordance with:
      a. The Drawing.
      b. These Specifications.
      c. The Shop Drawings reviewed by Engineer.
      d. The Manufacturer’s recommendations.
   2. System shall not interfere with passage, head room or openings of doors and windows.
   3. Pipe: Straight, without rust or other defects.
   4. Joints:
      a. Welded: Required for pipes 2-1/2 inches and larger, unless using grooved piping system.
      b. Screwed:
         1) Reamed after cutting and before threading.
         2) Sharp, clean threads.
         3) Use pipe compound on male threads only.

B. Mains and Branches:
   1. Install above the ceiling and in bar joists, above bottom chord, as indicated on the Drawings.
   2. Sizes as indicated on the Drawings.
   3. Install Tops of Mains Level:
      a. Use eccentric fittings at changes in pipe size.
      b. Provide adequate supports to prevent air pockets.
   4. Branches:
      a. Take off bottom of main.
      b. Provide swing connection before vertical riser to a heating unit or convector.

C. Risers and Vertical Pipes: Plumb, straight and without unnecessary fittings or offsets.
D. Fittings:
   1. Provide Air Vents:
      a. As indicated on the Drawings.
      b. At all high points on the system.
   2. Provide Drain Valves:
      a. At the bottom of all risers.
      b. At boiler.
      c. At all low points.
   3. Provide insulating couplings or unions where copper and steel pipes are joined.
   4. Provide unions at all valves and at all equipment for making repairs.

E. Valves:
   1. Provide Shutoff Valves:
      a. On both sides of all pumps where necessary to ensure proper operation of the system.
      b. On all branches at the main.
      c. So that equipment can be serviced without shutting down the system.
   2. Provide unions at all valves and at all equipment for making repairs.
3.2 SCHEDULES

SCHEDULE FOR
HYDRONIC PIPING
125 PSI MAXIMUM PRESSURE - 200 DEGREES F MAXIMUM TEMPERATURE

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>SCHEDULE</th>
<th>MATERIAL</th>
<th>ASTM</th>
<th>GRADE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>40</td>
<td>CW Steel</td>
<td>A53</td>
<td>B</td>
<td>Threaded and Coupled</td>
</tr>
<tr>
<td>2-1/2 – 12</td>
<td>40</td>
<td>ERW Steel</td>
<td>A53</td>
<td>B</td>
<td>Beveled End</td>
</tr>
<tr>
<td>14 – 24</td>
<td>375° Wall</td>
<td>Seamless Steel</td>
<td>A53</td>
<td>B</td>
<td>Beveled End</td>
</tr>
<tr>
<td>1/2 – 2</td>
<td>Type L</td>
<td>Seamless Copper</td>
<td>1388</td>
<td>--</td>
<td>50/50 Solder</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FITTINGS</th>
<th>SIZE (IN)</th>
<th>DESCRIPTION</th>
<th>ANSI</th>
<th>ASTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ells</td>
<td>1/2 – 2</td>
<td>150# Malleable Iron Screwed</td>
<td>B16.3</td>
<td>A197</td>
</tr>
<tr>
<td></td>
<td>2-1/2 – 18</td>
<td>Standard Weight Steel L.R. Butt Weld</td>
<td>B16.9</td>
<td>A234 WPA</td>
</tr>
<tr>
<td></td>
<td>1/2 – 2</td>
<td>Wrought Copper (Long Radius)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tees</td>
<td>1/2 – 2</td>
<td>150# Malleable Iron Screwed</td>
<td>B16.3</td>
<td>A197</td>
</tr>
<tr>
<td></td>
<td>2-1/2 – 18</td>
<td>Miter Branch &amp; Weld into Run or Butt Weld Tees</td>
<td>B16.9</td>
<td>A234 WPA</td>
</tr>
<tr>
<td></td>
<td>1/2 – 2</td>
<td>Wrought Copper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reducers</td>
<td>1/2 – 2</td>
<td>150# Malleable Iron Screwed</td>
<td>B16.3</td>
<td>A197</td>
</tr>
<tr>
<td></td>
<td>2-1/2 – 18</td>
<td>Standard Weight Steel Butt Weld</td>
<td>B16.9</td>
<td>A234 WPA</td>
</tr>
<tr>
<td></td>
<td>1/2 – 2</td>
<td>Wrought Copper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bushings</td>
<td>1/2 – 2</td>
<td>Outside Hex. Head Malleable Iron</td>
<td>B16.3</td>
<td>A197</td>
</tr>
<tr>
<td>Couplings</td>
<td>1/2 – 2</td>
<td>150# Malleable Iron Screwed</td>
<td>B16.3</td>
<td>A197</td>
</tr>
<tr>
<td></td>
<td>2-1/2 – 18</td>
<td>Butt Weld</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unions</td>
<td>1/2 – 2</td>
<td>150# Malleable Iron Screwed</td>
<td>B16.3</td>
<td>A197</td>
</tr>
<tr>
<td>Plugs</td>
<td>1/2 – 2</td>
<td>Malleable Iron Square Head Solid</td>
<td>B16.3</td>
<td>A197</td>
</tr>
<tr>
<td>Caps</td>
<td>1/2 – 2</td>
<td>Malleable Iron Screwed</td>
<td>B16.3</td>
<td>A197</td>
</tr>
<tr>
<td></td>
<td>2-1/2 – 18</td>
<td>Standard Weight Steel Butt Weld</td>
<td>B16.9</td>
<td>A234 WPA</td>
</tr>
<tr>
<td>Flanges</td>
<td>2-1/2 – 18</td>
<td>150# F.S. Slip-on Welding</td>
<td>B16.9</td>
<td>A181-I</td>
</tr>
<tr>
<td>Gaskets</td>
<td></td>
<td>Non-Asbestos Compressed Material</td>
<td>B16.21</td>
<td></td>
</tr>
<tr>
<td>Bolts</td>
<td></td>
<td>Regular &quot;Unfinished&quot; Square Head Machine</td>
<td>A307 Gr.B</td>
<td></td>
</tr>
<tr>
<td>Nuts</td>
<td></td>
<td>American Standard &quot;Heavy Series&quot; Semi-finished Hex</td>
<td>A194 Gr.2H</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VALVES</th>
<th>SIZE (IN)</th>
<th>DESCRIPTION</th>
<th>ENDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shut-Off</td>
<td>1/2 – 2</td>
<td>150# Brass Ball/Butterfly</td>
<td>Screwed/Soldered</td>
</tr>
<tr>
<td></td>
<td>2-1/2 – 18</td>
<td>150# Butterfly</td>
<td>Flanged</td>
</tr>
<tr>
<td>Throttling</td>
<td>1/2 – 2</td>
<td>125# Brass Ball/Butterfly</td>
<td>Screwed/Soldered</td>
</tr>
<tr>
<td></td>
<td>2-1/2 – 12</td>
<td>125# Butterfly</td>
<td>Flanged</td>
</tr>
<tr>
<td>Check</td>
<td>1/2 – 2</td>
<td>125# Bronze Swing Check</td>
<td>Screwed/Soldered</td>
</tr>
<tr>
<td></td>
<td>2-1/2 – 12</td>
<td>125# IBBM Swing Check</td>
<td>Flanged</td>
</tr>
</tbody>
</table>

Grooved Piping Application Schedule

| Application | Design Temperature Range | Maximum Pressure | Acceptable Pipe/Coupling
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Heating/air conditioning</td>
<td>-30 to 230 degrees F</td>
<td>300 psig</td>
<td>A (up to 2-1/2°), B (up to 2-1/2°)</td>
</tr>
</tbody>
</table>

Note - Pipe/Coupling Types:
A. Standard weight steel pipe.
B. Copper.

END OF SECTION 23 21 13
SECTION 23 21 23 – HYDRONIC 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. This Section includes the furnishing and installation of the HVAC pumps.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. American Society of Mechanical Engineers (ASME): B31.9 - Code for Building Services Piping.
   2. Underwriter's Laboratories, Inc. (UL).

1.4 SUBMITTALS

A. Manufacturer's Literature: For each pump.
   1. Pump make and model designation.
   2. Pump efficiency at design:
   3. Dimensions.
   4. Total head at design.
   5. Shut off head.
   6. Required NPSH at design.
   7. Motor Manufacturer, type and characteristics.
   8. BHP required at design conditions.
   11. Project specific wiring diagrams including control wiring.

B. Operation and Maintenance Manuals: For each pump.
   1. Equipment function, normal operating characteristics and limiting conditions.
   2. Assembly, installation, alignment, adjustment and checking instructions.
   3. Operating instructions for start-up, routine and normal operating, regulation and control, and shutdown and emergency conditions.
   4. Lubrication and maintenance instructions.
   5. Guide to "troubleshooting".
   6. Parts lists and predicted life of parts subject to wear.
   7. Outline, cross-sections, assembly drawings, engineering data and wiring diagrams.
   8. Test data and performance curves.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

1.6 DELIVERY, STORAGE AND HANDLING

A. All materials shall be delivered in original, unbroken, brand marked containers.

B. Handle and store materials in a manner which will prevent deterioration and contamination with foreign matter.
C. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace removed materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Bell & Gossett.

B. Armstrong Pumps, Inc.

C. Taco.

2.2 MANUFACTURED UNITS

A. In-Line Pumps:
   1. In-line type for installation in vertical or horizontal piping, capable of removal without disturbing piping.
   2. Pump Body:
      a. Class 30 cast iron.
      b. Rated 175 psi working pressure.
      c. Gage ports at nozzles.
      d. Vent and drain ports.
   3. Impeller:
      a. Nonferrous material.
      b. Enclosed type.
      c. Dynamically balanced.
      d. Keyed to the shaft and secured by a locking capscrew or nut.
   4. The liquid cavity shall be sealed from the pump bearing by an internally-flushed mechanical seal with ceramic seal seat of at least 98% alumina oxide content and carbon seal ring, suitable for continuous operation at 250 degrees F.
   5. A nonferrous shaft sleeve shall completely cover the wetted area under the seal.
   6. Pump Bearing Bracket:
      a. Oil lubricated bronze journal and thrust bearings.
      b. Bracket shaft: Alloy steel having ground and hardened thrust bearing faces.
      c. A flexible coupling to dampen starting torque and torsional vibrations shall be employed.

2.3 COMPONENTS

A. Motors: Comply with the requirements of Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 SOURCE QUALITY CONTROL

A. Factory align and run test pumps.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pumps in conformance with:
   1. The Drawings.
   2. These Specifications.
   3. The Shop Drawings reviewed by Engineer.
   4. The Manufacturer's recommendation.
3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Arrange and pay for Manufacturer's engineer to provide the services indicated below. Schedule the following as soon as practicable after installation, and at times approved by Engineer and Owner.
   1. Manufacturer's Engineer: Check work, assist in start-up, demonstrate operation and maintenance to Owner's personnel, and review operation and maintenance manual with Owner's personnel.

B. Promptly make all changes and additions required by Manufacturer's engineer.

C. Submit Manufacturer's engineer's written approval of installation. A factory trained and authorized local technician may be used.

END OF SECTION 23 21 23
SECTION 23 25 00 – 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 furnishing and installation of a complete water treatment system for closed circuit hydronic systems including, but not limited to, the major items listed below:
   1. Treatment chemicals: Sufficient for start-up and 1-year operation.
   2. Test equipment.

1.3 SYSTEM DESCRIPTION

A. Provide complete chemical treatment to control corrosion and scale at the heating water systems.

1.4 PERFORMANCE REQUIREMENTS

A. Maintain water quality for HVAC systems that controls corrosion and buildup of scale and biological growth for maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment.

B. Base chemical treatment performance requirements 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:
   1. Closed System: Maintain system essentially free of scale, corrosion and fouling.

1.5 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   2. American Society of Mechanical Engineers (ASME) publications:

1.6 SUBMITTALS

A. Manufacturer’s Literature:
   1. Name of all Manufacturers and suppliers of equipment and chemicals.
   2. Performance characteristics.

1.7 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

B. Manufacturer’s personnel shall be full-time employees of the chemical Manufacturer or authorized representative.
C. Testing of water samples in accordance with Division 01 Section “Special Inspections and Tests.”

D. Regulatory Agencies Requirements:
   1. All state and local codes and ordinances.
   2. Owner’s insurer.
   3. Environmental Protection Agency (EPA):
   4. Michigan Department of Environmental Quality (MDEQ).

PART 2 - PRODUCTS

2.1 MANUFACTURER/SUPPLIER

A. Chemical Treatment Chemicals:
   1. Aqua-Chem.
   2. Enerco.
   3. Aquatrol.
   5. Mitco.
   7. Eldon.

2.2 TREATMENT CHEMICALS

A. Furnish chemicals recommended by water treatment system Manufacturer that are compatible with piping system components and connected equipment.

B. Biocide: Chlorine release agents or microbiocides.

C. Closed Loop, Water Piping Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors and conductivity enhancers.

D. Provide SDS’s on all products supplied.

E. Scale, Corrosion, and Biological Growth Control: Furnish 1 year’s supply of the recommended formulas for control of scale, corrosion and biological growth:
   1. Separate products will be provided for preventing scale deposits and corrosion.
   2. The chemical products will be compatible with system materials of construction and operating conditions and will comply with all applicable regulatory agencies.

PART 3 - EXECUTION

3.1 GENERAL

A. Install equipment as directed by the Manufacturer.

3.2 CLEANING SYSTEMS

A. Refer to the requirements of Division 23 Section “Testing and Cleaning of HVAC Systems.”

END OF SECTION 23 25 00
SECTION 23 31 13 – METAL DUCTS

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 furnishing and installation of sheet metal ductwork and appurtenances:
   1. As indicated on the Drawings.
   2. As specified herein.
   3. As required to provide a complete and operational air distribution system.
   4. As necessary for the proper and complete performance of the Work.
   5. Including all hangers, supports and anchors.

1.3 DESIGN AND PERFORMANCE REQUIREMENTS

A. Provide all hangers, supports, braces and connections as required to meet the restraint requirements of Michigan Building Code and in accordance with the guidelines of the SMACNA Restraint Manual.

B. Comply with the requirements of Division 23 Section “Sound and Vibration Control for HVAC” for vibration isolation of ductwork.

1.4 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ASHRAE Guidelines:
      b. 2017 Fundamentals - Chapter 21 - "Duct Design."
      c. ASHRAE 62.1, current version.
   2. ASTM Specifications:
      a. A480 - General Requirements for Flat-Rolled Stainless Steel and Heat-Resisting Steel Plate, Sheet, and Strip.
      b. A653 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      c. A924 - General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
      d. B209 - Aluminum and Aluminum - Alloy Sheet and Plate.
   3. ASTM Standard Test Methods:
      a. A90 - Weight of coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
      b. C731 - Extrudability, after Packaging, Aging, of Latex Sealants.
      c. D2202 - Slump of Sealants.
   4. NFPA Standards:
      a. 90A - Installation of Air Conditioning and Ventilating Systems.
      b. 90B - Installation of Warm Air Heating and Air Conditioning Systems.
      c. 91 – Standard for Exhaust Systems for Conveying of Materials.
   5. SMACNA Guidelines:
   6. UL Standards: 181 - Factory Made Air Ducts and Connectors.

1.5 SYSTEM DESCRIPTION

A. Duct sizes indicated on Drawings are net clear inside dimensions.
B. Duct Construction Pressure Classifications:

<table>
<thead>
<tr>
<th>Duct System</th>
<th>SMACNA Pressure Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Supply duct downstream of terminal units</td>
<td>1&quot; W.G.</td>
</tr>
<tr>
<td>2. Supply duct upstream of terminal units</td>
<td>3&quot; W.G.</td>
</tr>
<tr>
<td>3. Return duct</td>
<td>1&quot; W.G.</td>
</tr>
</tbody>
</table>

1.6 SUBMITTALS

A. Manufacturer's Data: Sequential parts list for each part.
   1. Name of Manufacturer.
   2. Part name and model number.
   3. Dimensions.

B. Shop Drawings: Construction details for special fabricated parts.

C. Duct Pressure Test:
   1. Written procedure for leak testing installed supply and return ductwork system 30 days prior to testing.
   2. Duct pressure test report.

1.7 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

B. Regulatory Agencies Requirements:
   1. All state and local codes and ordinances.
   2. Owner's insurer.
   3. Flexible ductwork shall comply with:
      a. UL listed - Class 1 Air Duct Material, Standard 181.
      b. NFPA Standard 90A - Flame spread: 25, Smoke developed: 50.

1.8 DELIVERY, STORAGE AND HANDLING

A. All materials shall be delivered in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter and damage by weather or elements in accordance with Manufacturer's directions.

C. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Duct Connection Systems:
   1. Ductmate Industries, Inc.
   2. Lindab, Inc.

B. Flexible Duct:
   1. Flexmaster USA, Inc., Type 3 uninsulated or 3M insulated as specified.
   2. General Environment Corporation.
   3. Wiremold Company.
C. Prefabricated Fittings:
   1. United McGill Corporation.
   2. Buckley Air Products, Inc.
   3. Eastern Sheet Metal, Inc.
   4. LaPine Metal Products.
   5. Lindab, Inc.
   7. Universal Spiral Air.

D. Manufactured ductwork and fittings shall be of one Manufacturer to ensure tight fit of ductwork and components.

E. Manufacturer's Stamp:
   1. Manufacturer's stamp shall be on the outside of the ductwork.
   2. Stamp shall be clean and clear, indicating the metal gage.

2.2 MATERIALS

A. Galvanized Steel:
   1. Galvanized steel of lock-forming quality with minimum ASTM A653, G90 zinc coating, both sides in accordance with ASTM A90.
   2. Use for all ductwork systems unless noted otherwise.

B. Acceptable Fasteners:
   1. Rivets, bolts, or sheet metal screws.
   2. Stainless steel.

C. Tapes:
   1. High pressure rated, non-hardening, water resistant and fire-resistant.
   2. Compatible with duct material.

D. Sealants:
   1. Fire and Smoke Hazard Rating:
      a. As tested by ASTM E84, NFPA 255, or UL 723.
      b. Not to exceed: Flame spread 25, smoke developed 50.
   2. Exterior Mastic Sealant: Certified to pass 600 hours QUV; or equivalent weather testing.
   3. Comply with ASTM C731 and D2202.
   4. Specifically formulated for sealing the field joints.
   5. UL listed.

E. Hangers:
   1. Galvanized steel band iron.
   2. Rolled angle and 3/8-inch minimum galvanized steel rod.

F. Wall Supports:
   1. Galvanized steel band iron.
   2. Fabricated angle bracket.

G. Vertical Supports at Floors:
   1. Rolled steel angle 1-1/2 x 1-1/2 x 1/8 minimum.
   2. Mechanically attached to duct.

2.3 FABRICATION

A. General: Construct rectangular, round and flat oval ductwork and fittings in accordance with the SMACNA HVAC Duct Construction Standards, Metal and Flexible, current edition.
B. Transitions: Make every change in size or shape of duct with taper not exceeding 20 degrees.

C. Connections:
   1. Make connections to equipment as indicated on Drawings or called for by these Specifications.
   2. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws
      2-inch on center.
   3. Flexible Ductwork Connections:
      a. Securely fasten flexible duct to round sheet metal ducts or duct collars with stainless steel or zinc-
         coated iron draw bands with worm gear fastener.
      b. Flexible duct 10-inch diameter or less, installed on 1-inch W.G. pressure classification duct may
         be attached with nylon cable ties.
      c. Fabric shall not be stressed other than by air pressure.

D. Elbows and Tees:
   1. Maintain centerline radius of 1-1/2 times duct width in plane of turn wherever possible.
   2. Provide short radius fittings with a minimum of 2 turning vanes full length of turn or square elbows with
      multiple blade airfoil turning vanes set at 45 degree angle.
      OR
   3. Provide rectangular mitered elbows with acoustic turning vanes as indicated on the Drawings. Refer to
      Division 23 Section “Sound and Vibration Control for HVAC” for acoustic turning vanes.
   4. Where mitered elbows are not indicated on the Drawings: Maintain centerline radius of 1-1/2 times duct
      width in plane of turn.

E. Turning Vanes and Distribution Devices: Where registers, grilles or diffusers are located less than 5 equivalent
   duct diameters from the main duct, provide necessary distribution grids or turning vanes to ensure even
   distribution of air over the entire face of the outlet.

F. Obstructions:
   1. Wherever a pipe or other obstruction passes through a duct (this condition is to be avoided if possible),
      pass the obstacle through an airfoil sleeve in the duct.
   2. Increase duct area at the obstruction if more than 20% of duct area is displaced by obstruction.
   3. Streamline sleeve to maintain angles at duct size changes at 20 degree angle.

G. Provide necessary plastering frames and drawbands required.

H. Branch Ducts:
   1. Construct with full radius elbow turning into a transition section in the main duct.
   2. Provide with damper and quadrant as specified in Division 23 Section “Dampers.”

2.4 MANUFACTURED UNITS

A. Turning Vanes:
   1. Hem the leading edge of vanes in ducts over 20-inch width with 1/2-inch fold-back.
   2. Reinforce turning vanes in ducts over 24-inch diameter with rods or sectional construction to limit
      unsupported length to 24 inches.
   3. 20 gage, minimum.
   4. Use in rectangular elbows with R/D ratio of less than 1.5.
   5. Double wall.

B. Takeoffs from Round 1-inch Pressure Classification Duct:
   1. Made with factory fabricated lateral type fittings.
   2. At an angle of no more than 45 degrees.
   3. As manufactured by United McGill Corp., Model SRL; or approved equal.
   4. In accordance with detail on Drawing.
C. Flexible Duct:
1. Construction:
   a. Liner of laminated aluminum foil/fiberglass/aluminated polyester.
   b. Aluminum helix bonded to liner.
   c. 1-inch thick, 1 pound/cubic foot insulation.
   d. Seamless copolymer vapor barrier jacket.
   e. Rated for pressure class of system in which duct is used.
2. Maximum flexible duct length shall not exceed 5 feet, maximum flex duct turn not to exceed 45 degrees.

D. Manufactured Ductwork Connection Systems:
1. General:
   a. In lieu of SMACNA Duct Construction Standards, Contractor may use an alternative engineered connection system such as Ductmate, “Spirosafe” by Lindab; or approved equal.
   b. Designed to provide equivalent reinforcing and pressure characteristics.
2. Description:
   a. Duct, gasket, and fitting providing an airtight outer pressure shell.
   b. The construction shall have mechanical means to maintain positive or negative pressure requirement, or both, and rigidity equivalent to SMACNA joints and metal gages.
3. Duct Material:
   b. Metal Gage: As required to meet pressure classification indicated.
4. Fittings:
   a. As indicated on Drawing and of same Manufacturer as duct section.
   b. Sized to slip fit into the duct sections, without sharp projections for noise and airflow disturbances.

E. Round Ductwork:
1. Duct Material:
   b. Inner Liner: Perforated galvanized steel.
   c. Metal Gage: As required to meet pressure classification indicated.
2. Insulation: Comply with the requirements of Division 23 Section “Sound and Vibration Control for HVAC” for internal duct liner.
3. Fittings:
   a. As indicated on Drawing and of same Manufacturer as duct section.
   b. Sized to slip fit into the insulated duct sections, without spaces for air erosion of insulation or sharp projections for noise and airflow disturbances.
   c. Butt joints are not suitable for the inner liner of double wall duct.

2.5 DUCT ACCESS DOORS

A. Manufacturers:
1. Prefco.
2. Pottorf.

B. Provide In Ductwork:
1. Wherever necessary for proper access to instruments, controls, fire dampers, motorized dampers, coils and equipment.
2. For convenient inspection, maintenance and replacement.
3. Reinforce openings on sides with material or ductwork in which doors are installed.

C. Construction:
1. Two-piece 22 gage minimum pan construction, consisting of outer side crimped over inner dished side.
2. Continuous piano hinge and not less than 2 heavy cam latches. A removable type door is acceptable only where there is inadequate clearance for a hinged door.
3. Contact surfaces of doors covered with heavy dense felt securely fastened in place to make doors air tight.
4. Insulated or soundproofed with same materials as ducts or casings where located.
5. Ruskin ADH22 or ADC22; or equal.
2.6 SOURCE QUALITY CONTROL

A. Certified Testing:
1. **Suppliers of manufactured round and oval ductwork shall have on file with Engineer certified copies of**
   test data made by an independent United States laboratory covering pipe and fittings as manufactured
   by that Supplier.
2. **Spiral Pipe Test Data:**
   a. Cover leakage rate, bursting strength, collapsing strength, seam strength and friction loss.
   b. Friction loss test data shall cover both the duct and the assembled coupling joints.
   c. This friction loss data shall be equal to or less than the friction loss data used in the design of this
      system.
3. **The fitting test data shall cover the friction loss tests of all fittings used on the project.**

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Install ductwork and accessories to provide a system free from buckling, warping, breathing, vibration,
   rattling, or whistling.
2. Lap ducts in direction of air flow with longitudinal seams locked and hammered tight.
3. Provide flat "S" cleats on all exposed traverse duct connections in finished areas.
4. Install ducts straight with building walls where possible and exposed duct tight against roof or walls
   where possible.
5. Ducts shall be air-tight, rigid, securely hung or bracketed in position.
6. At the end of an uninsulated section or run, where internally insulated duct connects to uninsulated spiral
   duct or fitting, fire damper or flex, install an insulation end fitting to bring the outer shell down to nominal
   size.
7. Install screws and rivets of such length that they do not interfere with the operation of manual or
   automatic dampers.
8. Provide 1-inch long metal nosing around entire duct perimeter at all exposed and leading edges of
   internal acoustic ductwork lining.

B. Protection of System:
1. Cap the ends of sheet metal ductwork, including the roof openings, registers and diffuser openings with
   temporary sheet metal caps during all stages of construction in order to keep system clean.
2. If permanent heating and cooling equipment is used prior to Substantial Completion, protection of
   ductwork systems shall comply with Division 23 Section “General HVAC Provisions.”

C. Hanging Duct:
1. Allow swing in long direction of duct for movement.
2. Double nut hanger rods.

D. Duct Anchoring:
1. Galvanized sheet metal hanger straps attached to construction.
2. Angle metal screwed to the ductwork.

E. Turning Vanes:
1. Use in rectangular mitered elbows with R/D ratio of less than 1.5 and elsewhere as indicated.
2. Install evenly spaced along elbow diagonal with leading and trailing edges aligned to sides of duct.
3. Install vanes on 3-3/4-inch centers.
4. Elbows Where Duct Changes Size:
   a. Mount vanes individually (not on premanufactured vane runners).
   b. Ensure that leading and trailing edges align parallel to sides of duct.
F. Joint Sealing of Duct Systems:
   1. Except where using gasketed duct connection systems, seal ductwork in accordance with SMACNA Class A:
      a. Seal ductwork including supply, return, mixed, outdoor, and exhaust air systems.
      b. For Round and Flat Oval Ductwork:
         1) Apply approved sealant to the male end of the couplings and fittings.
         2) After the joint is slipped together, place sheet metal screws 1/2-inch from the joint bead for mechanical strength.
         3) Apply sealer to the outside of joints including longitudinal joints, extending 1-inch on each side of the joint.
         4) Cover screw heads.
      c. For Rectangular Ductwork:
         1) Apply approved sealant to transverse and longitudinal joints.
         2) Extend sealant a minimum of 1-inch on each side of joint.
      d. Follow sealant Manufacturer’s directions for application, storage and cure time.
   2. Manufactured Connection Systems:
      a. Acceptable in accordance with Paragraph 2.1.
      b. Seal flanged joints with neoprene rubber gaskets.

G. Appearance: Where exposed ducts pass through walls or floors: Refer to Division 23 Section “Penetrations for HVAC.”

3.2 HANGING AND SUPPORT

A. All Ducts:
   1. Support in a secure manner.
   2. Subject to Engineer’s approval.

B. In accordance with Section IV of the SMACNA HVAC Duct Construction Standards.

C. Unacceptable work shall be removed and replaced at no additional cost to Owner.

3.3 FIELD QUALITY CONTROL

A. Duct Systems to be Tested:
   1. Supply ducts.
   2. Return ducts.
   3. Exhaust ducts.

B. Pressure Testing:
   1. Pressurize the installed duct system to a test pressure 50% over the designated SMACNA pressure classification.
   2. Measure air leakage at the test pressure by an orifice type of flow meter which has been individually calibrated against a primary standard and this calibrated curve permanently attached to the orifice tube assembly.
   3. If the system is tested in sections, add the leakage rates to give the performance of the whole system.
   4. Total allowable leakage of the system shall not exceed 1.0% of the air handling capacity of the system.
   5. Correct Objectionable Noise:
      a. Even if the system passes the leakage rate criteria.
      b. To the satisfaction of Engineer.
   6. Apply duct tape over sealed joints prior to testing, if the system is to be tested before the recommended sealer curing time has elapsed.

C. Perform testing in accordance with a printed procedure reviewed by Engineer.

D. Notify Engineer 1 week prior to duct pressure test to allow Engineer the option to be available to observe testing.
E. Pressurization Control:
   1. Protection against duct overpressurization or underpressurization during testing is the responsibility of Contractor.
   2. Verify that control, variable air volume, balancing, and fire dampers are open.
   3. Verify that pressure relief panels or controls are operational.

END OF SECTION 23 31 13
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, but is not limited to, the major items listed below:
   1. Fire dampers.
   2. Control dampers.

B. Division of Work:
   1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the Work to be performed by specific trades.
   2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the Work:
      a. Mechanical Subcontractor:
         1) Install control dampers.
         2) Provide manual dampers.
      b. Temperature Control Subcontractor:
         1) Furnish control dampers, linkages and operators unless specifically noted otherwise on Drawings.
         2) Install linkages and operators on dampers.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the Work of this Section shall comply with the following:
   2. SMACNA Publications:
      b. HVAC Duct Construction Standards - Metal and Flexible.
   3. ASTM:
   4. UL:
      a. 555 - Fire Dampers.
      b. 555C - Ceiling Dampers.

1.4 SUBMITTALS

A. Manufacturer's Literature:
   1. Submit For:
      a. Fire dampers.
      b. Duct access doors and panels.
      c. Control dampers.
   2. Required Information:
      a. General:
         1) Dimensions.
         2) Details of construction and installation.
         3) Name of Manufacturer.
         4) Model.
b. Control Damper:
   1) Air pressure drop.
   2) Leakage rate.
   3) Performance data as tested in accordance with AMCA Standards.

B. Operation and Maintenance Manuals: For each type of VAV damper.
   1. Equipment function, normal operating characteristics and limiting conditions.
   2. Assembly, installation, alignment, adjustment and checking instructions.
   3. Operating instructions for start-up, routine and normal operating, regulation and control, and shutdown and emergency conditions.
   4. Lubrication and maintenance instructions.
   5. Guide to "troubleshooting."

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

B. Regulatory Agencies Requirements:
   1. UL: Fire dampers shall conform to UL 555 and bear the UL label.
   2. Installation and materials shall be in accordance with:
      a. All state and local codes and ordinances.
      b. Owner's insurer.

1.6 SEQUENCING AND SCHEDULING

A. Installation of control components at the Manufacturer's factory or in the field is optional only to the extent that schedule is not adversely affected.

PART 2 - PRODUCTS

2.1 AIRFLOW REGULATING DAMPERS

A. Manufacturers:
   1. Dampers:
      a. American Warming and Ventilating, Inc.
      b. Ruskin.
      c. Louvers and Dampers, Inc.
      d. Greenheck.

B. Provide accessible, manually operable dampers:
   1. At branch duct take-offs.
   2. At diffuser run-out take-offs.
   3. Downstream of duct coils.
   4. As indicated on the Drawings by the manual balancing damper symbol.

C. Dampers for Round Duct:
   1. For 8-inch and smaller, premanufactured dampers equal to Hart & Cooley 608/66 series.
   2. Field Fabricate Dampers:
      a. Blade:
         1) Galvanized steel.
         2) Two gages heavier than duct in which installed.
      b. Pivot rod continuous, 3/8-inch minimum for 12 inches and larger, 1/4-inch for under 12-inch size.
      c. Hardware:
         1) For dampers less than 12 inches round, provide a dial regulator set consisting of 1 dial regulator, 1 square end bearing and 1 spring end bearing; equal to Durodyne Set No. KS-145 or KS145L.
2) For dampers larger than 10 inches round, provide a dial regulator set consisting of 1 dial regulator, 1 square end bearing and 1 spring end bearing equal to Durodyne Set No. KSR-195 or KSR-195L.

D. Dampers for Rectangular Duct:
   1. Field Fabricate Single Blade Dampers:
      a. Blade:
         1) Galvanized steel.
         2) Two gages heavier than duct in which installed.
         3) 12-inch maximum height.
      b. Pivot Rod:
         1) 3/8-inch pins up to 18-inch wide.
         2) 1/2-inch continuous rod over 18-inch wide.
   2. Dampers with Vertical Dimension Over 12 Inches:
      a. Use opposed blade type.
      b. Blade:
         1) 18-gage minimum galvanized steel.
         2) 12-inch maximum blade height.
         3) Hardware.

E. Regulator:
   1. Quadrant type with handle and wingnut.
   2. Provide with integral insulation flange or standoff for installations on insulated ductwork.
   3. Provide end bearing.
   4. Equal to Duro Dyneset KS-12.

F. Dampers Upstream of Coils: Opposed blade type.

2.2 FIRE DAMPERS

A. Manufacturers:
   1. Prefco.
   2. Ruskin.
   4. Louvers and Damper, Inc.

B. General Requirements:
   1. Dynamic rated.
   2. Fusible link actuated.
   3. Type B, 100% minimum free duct area with blade out of airstream.
   4. Installation of Type “A” fire dampers in an oversized duct is not an acceptable substitute for Type “B”.
   5. UL Classified Fire Resistance Rating: 1-1/2 hours.
   6. Size dampers at grilles same size as grille unless otherwise noted.

C. Provide where indicated on the Drawings and at code required locations in rated walls, floors and roofs.

D. Test fire dampers in accordance with:
   1. UL Standard 555 or;
   2. A nationally recognized, qualified testing laboratory approved by the local authority:
      a. Bearing the approved label of that laboratory.
      b. Installed in accordance with test installation.

2.3 INSTRUMENT TEST HOLES

A. Manufacturer: Ventlock Model 699; or equal.
B. Provide at control points including but not necessarily limited to:
   1. Air temperature controller sensors.
   2. Pressure sensors.
   3. Temperature limit devices.
   4. Locations determined by Test and Balance Engineers.

C. Compatible with duct external insulation thickness.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install duct accessories in conformance with:
      a. The Shop Drawings reviewed by Engineer.
      b. SMACNA HVAC Duct Construction Standards and Fire, Smoke and Radiation Damper Installation Guide.
      c. These specifications where different from SMACNA.
      d. Manufacturer's written instructions.
   2. Locate branch dampers used for air flow regulation as close as possible to main trunks.
   3. Dampers shall not rattle or generate airborne noise of any kind regardless of damper position.
   4. Dampers located upstream of coils shall not interfere with uniform velocity profile at coil face.
   5. Locate and orient duct accessories according to Manufacturer's instructions relative to nearby fittings, elbows, and fans.
   6. Verify that dampers move freely through their entire stroke without binding.

B. Access:
   1. Concealed duct accessories requiring inspection, service or maintenance shall be accessible.
   2. Provide acceptable means of access.
   3. Ensure that damper operator handles are not covered by insulation.

END OF SECTION 23 33 13
SECTION 23 36 00 – 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. This Section includes the furnishing and installation of all variable air volume (VAV) terminal units.

B. Cash Allowances: Work listed below to be completed by the temperature control system (T.C.S.) Subcontractor will be paid for from a cash allowance as specified in Division 01 Section “Cash Allowances” and performed by a T.C.S. contractor selected by Engineer.

C. Division of Work:
   1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.
   2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
      a. General Contractor:
         1) Install access hatches for terminal units:
            a) As directed by Mechanical Subcontractor.
            b) As specified in Division 08 Section "Access Doors and Frames."
      b. Mechanical Subcontractor:
         1) Furnish all access doors:
            a) As required for access to concealed terminal units.
            b) In accordance with Division 08 Section "Access Doors and Frames."
         2) Coordinate with General Contractor for access hatch locations and installation.
         3) Furnish and install VAV terminal units in ductwork system and provide hangers and support.
      c. Temperature Control Subcontractor:
         1) Provide control components:
            a) Furnish to VAV terminal unit Manufacturer.
            b) Complete field installation and calibrate.

1.3 SYSTEM DESCRIPTION

A. General:
   1. The assemblies shall be pressure independent and be able to reset to any airflow between 0 and a maximum cataloged cfm.
   2. Devices using cfm limits are not acceptable.
   3. Units shall be capable of morning warm-up operating control sequence.

B. Design and Performance Requirements:
   1. Air leakage less than 2% at 0.5 inches w.c. static pressure.
   2. Control (pneumatic) air usage less than 0.02 SCFM at 20 psig.
   3. Space NC less than 35 at 2000 fpm inlet velocity.

1.4 SUBMITTALS

A. Shop Drawings: For all terminal units.
   1. General:
      a. Dimensions.
      b. Details of construction and installation.
      c. Name of Manufacturer.
      d. Model.
2. For Each Unit:
   a. Identify by schedule Tag No.
   b. Air pressure drop at maximum position for specified airflow.
   c. Acoustic data at specified maximum and minimum airflows.
   d. Coil performance data.
   e. Fan performance data.
   f. Electrical characteristics and project specific wiring diagrams including controls wiring.

B. Operation and Maintenance Manuals: For each type of VAV terminal unit.
   1. Equipment function, normal operating characteristics and limiting conditions.
   2. Assembly, installation, alignment, adjustment and checking instructions.
   3. Operating instructions for startup, routine and normal operating, regulation and control, and shutdown and emergency conditions.
   4. Lubrication and maintenance instructions.
   5. Guide to "troubleshooting".
   6. Parts lists and predicted life of parts subject to wear.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

B. Regulatory Agencies Requirements:
   1. The entire unit including heating coils shall be UL listed and labeled.
   2. All insulation in accordance with:
      a. UL 181 for erosion.
      b. NFPA 90A for fire and smoke.
   3. Installation shall comply with:
      a. All state and local codes and ordinances.
      b. Owner's insurer.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate with sheet metal Subcontractor for scheduling of terminal unit installation so as to not delay the job.

B. Installation of control components at the Manufacturer's factory or in the field is optional only to the extent that schedule is not adversely affected.

1.7 WARRANTY

A. Warranty shall cover all component parts for a period:
   1. Not less than 36 months.
   2. Beginning from date of shipment.

B. Manufacturer shall bear all costs:
   1. For establishing and defining cause of unit's failure to perform as specified.
   2. For correcting or replacing all nonperforming units.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Nailor.
B. Kreuger.
C. Titus.
D. Price.
E. Siemens.

2.2 MANUFACTURED UNITS

A. Casing:
   1. Minimum 22 gage galvanized steel.
   2. Internally Lined:
      a. Comply with the requirements of Division 23 Section “Duct Insulation” for internal lining material.
      b. 1-inch closed cell insulation.
      c. 4 pound duct density.
      d. Foil faced mylar lined.
      e. Cut edges shall be scaled with metal barriers.
   3. Full bottom access door.

B. Damper:
   1. Galvanized steel or aluminum center pivot single blade or concentric sliding valve.
   2. Gasketed for positive closure.

2.3 COMPONENTS

A. Terminal Control Components - Electronic:
   1. Airflow Sensor and Transducer:
      a. Multi-point airflow pick-up to provide a factory piped differential pressure signal to an airflow transducer assembly.
      b. The pick-up shall maintain air accuracy of (±) 5% of the normal operating range of the terminal as a minimum.
      c. Integral flow taps and a calibration chart shall be provided with each unit.
   2. Terminal Damper Actuator - Electronic:
      a. Direct coupled actuator used to control the primary air damper of the terminal control unit.
      b. Constant current and torque limiting.
      c. The actuator shall be factory mounted, wired and installed by the terminal unit Manufacturer.
      d. Fully compatible with the electronic control signal for the T.C.S.
      e. The actuator shall be capable of providing a minimum of 35-inch pounds of torque.
      f. Capable of going from full open to full closed (or vise versa) in a maximum of 60 seconds.
   3. Terminal Box Controller Module: Refer to Division 23 Section “Instrumentation and Control for HVAC” for controller module requirements.
   4. Terminal Damper Actuator:
      a. Direct coupled actuator used to control the primary air damper of the terminal control unit.
      b. The actuator shall be capable of providing a minimum of 35-inch pounds of torque.
      c. Capable of going from full open to full closed (or vise versa) in a maximum of 60 seconds.
      d. Pneumatic cylinder type.
      e. 5 - 10 psig spring range.
5. Volume Controller:
   a. Pressure independent.
   b. Independent adjustment of minimum and maximum CFM setpoints.
   c. Direct or reverse acting as required by control sequence.
   d. Maximum 1.3 SCFH air consumption.

2.4 ACCESSORIES

   A. Hot Water Coils: Comply with the requirements of Division 23 Section “Radiant – Heating Hydronic Piping.”

2.5 TERMINAL CONTROL UNIT POWER REQUIREMENTS

   A. All air terminal units shall be designed for single point power connections.

PART 3 - EXECUTION

3.1 INSTALLATION

   A. As indicated on the Drawings.

   B. In accordance with Manufacturer's installation instructions.

END OF SECTION 23 36 00
SECTION 23 37 00 – AIR OUTLETS AND INLETS

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 furnishing and installation of all air inlet and outlet devices.

B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. AMCA Publications: Standard 511 - Certified Ratings Program for Air Control Devices.

1.4 SUBMITTALS

A. Manufacturer's Literature: For all items specified herein.
   1. General:
      a. Dimensions.
      b. Details of construction and installation.
      c. Name of Manufacturer.
      d. Model.
   2. Performance at Scheduled Airflow:
      a. Maximum supply outlet throw value based on 50 fpm terminal velocity.
      b. Maximum air pressure drop in inches water gage.
      c. Maximum noise criteria (NC) level.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

PART 2 - PRODUCTS

2.1 REGISTERS, GRILLES, DIFFUSERS

A. Manufacturers:
   1. Titus.
   2. Price

B. General Construction Features:
   1. Refer to the Drawings for styles, types and design and materials.
   2. Return registers and grilles shall have fixed fins.
   3. Provide opposed blade, key operated dampers with registers.
   4. Provide sponge rubber gaskets at mounting flanges.
   5. Fit units with concealed mounting screws.
6. Linear slot diffuser plenums with 1/2-inch glass fiber material treated for surface erosion.
7. Frame:
   a. Provide factory manufactured frame to allow proper mounting to surface in which installed, i.e., plaster, concrete, T-bar, splined ceiling, etc.
   b. Coordinate each case with architectural Drawings.

C. Finish:
   1. Manufacturer's standard paint; color selected by Architect.
   2. Anodized acceptable where standard for specific item.
   3. Off-white color for suspended ceiling installations, except where noted as black.

D. Accessories:
   1. Provide where indicated or required.
   2. Equalizing grid.

E. Manufacturer/model numbers are scheduled on Drawings to indicate performance criteria, appearance style and quality of materials.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow Manufacturer's instructions, subject to Engineer's approval.
B. Install registers, grilles and diffusers only after finish painting has been completed.
C. Install fixed vane return and exhaust grilles with angle of vanes perpendicular to normal line-of-sight.

3.2 ADJUSTING

A. Set pattern controllers on slot diffusers and set vanes on adjustable diffusers to provide air flow patterns as indicated on the Drawings.

3.3 PAINTING

A. Unlined Ductwork:
   1. Where visible behind registers, grilles and diffusers.
   2. Apply flat black paint:
      a. 2 coats.
      b. In accordance with Division 09 – Finishes.

END OF SECTION 23 37 00
SECTION 23 40 00 – HVAC AIR CLEANING 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. This Section includes, but is not limited to, the furnishing and installation of air cleaning devices:
   1. Permanent air filters.
   2. Disposable air filters.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:

1.4 SUBMITTALS

A. Filter Schedule:
   1. List each filter application individually, including:
      a. Type(s) of filter(s) applied.
      b. Manufacturer and model number for each type used.
      c. List filters by size and quantity.

B. Manufacturer's Literature: For each separate installation.
   1. Dimensions.
   2. Name of Manufacturer.
   3. Model.
   4. Certified performance data.
      a. Efficiency.
      b. Air pressure drop at stated airflow.
   5. Filter frame materials of construction.
   6. Motor specification, electrical characteristics, connections.

C. Cleaning and maintenance instructions.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. State and local codes and ordinances.
   2. Owner's insurer.
   3. UL listed and labeled Class 2.

1.6 DELIVERY, STORAGE AND HANDLING

A. All materials shall be delivered in original, unbroken, brand marked containers or wrapping as applicable.
B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter and damage by weather or elements in accordance with Manufacturer's directions.

C. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. American Air Filter.

B. Camfil Farr Company.

C. Flanders.

D. Cambridge.

E. Fiberbond.

F. Trion, Inc. (Electrostatic only).

2.2 DISPOSABLE MEDIA FILTERS

A. Cartridge Filters:
   1. Media: UL 900 Class 1 pleated, non-woven cotton fabric, scrim reinforced; supported by welded steel retainer; in 16 gage, 0.0598-inch steel holding frame with corrosion resistant coating.
   2. Welded wire media support grid.
   4. Galvanized steel enclosing frame with diagonal supports on entering and leaving sides of filter.
   5. Effective Media Area: 16 sq ft per 1000 CFM capacity rating.
   6. Nominal Size: 24 x 24 x 12 inches deep.
   7. ASHRAE 52.2 Performance:
      b. 85% average arrestance by weight.
      c. Initial Resistance at 500 FPM Face Velocity: 0.20-inch WG.
      d. Recommended Final Resistance: 0.50-inch WG above initial resistance.

2.3 FILTER HOUSINGS:

A. Minimum 16-gage galvanized steel (14-gage for HEPA filters).

B. Two access doors with neoprene gaskets, full height hinges and tight sealing clamp type closures.

C. Extruded aluminum tracks or 14-gage minimum mounting grid designed to accommodate intended filters without leakage.

2.4 ACCESSORIES

A. Holding Frames:
   1. Compatible with filters.
   2. 16-gage minimum galvanized steel for disposable.
   3. Flush mitered corners.
B. Differential Pressure Gage:
   2. Range: 0 to 2.0-inch water column.
   3. Size: 4-inch diameter dial readout.
   5. Connections: Use rubber hose to connect tips to gage.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install in such a manner as to prevent air leakage around filter/frame assembly.
   B. Provide additional support for banks of frames over 3 frames high.
   C. Calk around the perimeter of assembled frames.
   D. Mount static pressure tips with angled end portion upstream.

3.2 SCHEDULE
   A. Filter Applications:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Air Cleaning Device</th>
<th>Units</th>
<th>Thickness</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rooftop Units –Filter</td>
<td>Cartridge Filter</td>
<td>RTU-1</td>
<td>4”</td>
<td>MERV 8</td>
</tr>
</tbody>
</table>

END OF SECTION 23 40 00
SECTION 23 74 43 – PACKAGED, OUTDOOR HEATING AND COOLING 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. Refer to Division 23 Section "Wind Restraint Controls for HVAC" for wind restraint requirements related to this section.

1.2 SUMMARY

A. This Section includes the furnished and installation of packaged rooftop air handling unit(s).

1.3 SYSTEM DESCRIPTION

A. General:
   1. Factory assembled packaged unit suitable for roof-mounting and outdoor installation.
   2. All components functionally joined on a common base.
   3. Complete in every way, ready for electrical, ductwork, piping and control connections.

B. Major components include, but are not necessarily limited to, the following:
   1. Gas heating section.
   2. Filter module.
   4. Economizer section.
   5. Compressor/condenser system with DX coil.
   6. Mixing box section.
   7. Prefabricated curb, see design requirements.
   8. Factory-mounted controls.
   11. 120 Volt GFCI receptacle.
   12. Side access disconnect.
   13. Variable frequency drive for supply and exhaust fan motor.

C. Design and performance requirements as indicated on the Drawings.

1.4 SUBMITTALS

A. Shop Drawings: For complete unit.
   1. Manufacturer's name and model number.
   2. Dimensioned Drawings:
      a. Curb.
      b. Unit plan and elevation.
   3. Size and Performance Data:
      a. Fans.
      b. Refrigeration equipment.
      c. Heating section.
   4. Details of construction and installation.
   5. Project specific electrical wiring diagrams including controls wiring.
   6. Control schematic.

B. Operation and Maintenance Manuals: For completed unit and individual components.
   1. Equipment function, normal operating characteristics and limiting conditions.
   2. Assembly, installation, alignment, adjustment and checking instructions.
3. Operating instructions for start-up, routine and normal operating, regulation and control, and shutdown and emergency conditions.
4. Lubrication and maintenance instructions.
5. Guide to "troubleshooting".
6. Parts lists and predicted life of parts subject to wear.
7. Outline, cross-sections, assembly drawings, engineering data and wiring diagrams.
8. Test data and performance curves.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.

B. Manufacturer's Services:
   1. Provide start-up supervision by factory-employed personnel of installed unit.
   2. Provide training for Owner's personnel.

C. Regulatory Organizations Requirements:
   1. All electrical wiring must comply with NEC.
   2. Comply with all applicable state and local codes and ordinances.

1.6 SEQUENCING AND SCHEDULING

A. Expedite approval of Shop Drawings so as not to delay unit installation.

1.7 WARRANTY

A. Provide extended warranty of 5 years total on all compressors from equipment startup.

B. Provide 25-year warranty on stainless steel heat exchangers.

1.8 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Performance:
   1. Determined by designer in accordance with the basic parameters indicated on the Drawings and procedures indicated in the Building Code.
   2. Design shall not consider shielding by adjacent structures.
   3. Roof curb design shall be provided and certified by roof curb designer, Thybar, or equal. Roof curb shall be provided and installed by others. See specification section "Wind Restraint Controls" and section "Sound and Vibration Control for HVAC".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Trane.

B. Daikin.

C. York.

D. Design is based on equipment as scheduled. Changes in equipment Manufacturer must meet minimum requirements listed in this Specification or on Drawings and be compatible with facility and intended use. Contractor shall be responsible for any additional costs caused by selection of equipment from the list of acceptable alternative Manufacturers, including any redesign efforts by the Engineer.
2.2 CABINET, CASING AND FRAME

A. Frame and Base Unit:
   1. 14 gage galvanized steel.
   2. Provide lifting brackets with lifting holes.

B. All cabinet walls, access doors and roof shall be fabricated of rigid, impact resistant, double wall, high performance composite panels with G90 galvanized steel on both sides (20 gauge minimum interior wall and 18 gauge minimum exterior wall) and a closed cell polyurethane foam interior core.

C. Foam shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610 degrees F.

D. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, minimum 8 inches of positive or negative static pressure. Deflection shall be measured at the midpoint of the panel height and width.

E. Access: Access to filters, dampers, cooling coils, heaters, supply fans, return fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.

F. Cabinet leakage rate shall not exceed 1% when tested at 6 inches of static pressure.

G. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.

H. Sealants shall comply with EPA Method 24 40 CFR 59, Subpart D for VOC content.
   1. Metal to Metal: 30 g/L.
   2. Fiberglass: 80 g/L.

I. Insulation:
   1. All cabinet surfaces and access panels.
   2. Minimum 13.0 R value.
   3. Double wall with thermal break construction with no metal path from inside to outside.
   4. Foam in place insulation.
   5. 1-1/2” lb density insulation.

2.3 SUPPLY FAN AND EXHAUST FAN

A. Fan:
   1. Double width, double inlet air foil centrifugal type.
   2. Statically and dynamically balanced.
   3. Wheel and housing to be of galvanized steel.
   4. Shaft:
      a. Solid steel.
      b. Mounted in 200,000-hour rated, relubricatable ball bearing assemblies.

B. Motor: Comply with the requirements of Division 23 Section “Common Motor Requirements for HVAC Equipment.” Provide with variable speed drive factory-wired and mounted.

C. Vibration Isolation:
   1. Completely isolate entire fan assembly from the unit bulkhead with spring isolators.
   2. Provide spring isolation of compressors.
   3. Entire unit shall be mounted on a neoprene gasket between the unit and the curb.
   4. Comply with the requirements of Division 23 Section “Sound and Vibration Control for HVAC.”
2.4 FURNACE

A. Burner:
   1. Forced draft, natural gas fired low modulating type capable of efficient operation from 33% through
      100% of rated capacity.
   2. Factory fire tested and adjusted prior to shipment.

B. Heat Exchanger:
   1. Tubular type.
   2. All parts fabricated of type 304 stainless steel.
   3. Secondary heat exchanger design shall permit free expansion and contraction of individual sections and
      tubes.
   4. Provide for heat exchanger cleaning without removing casing panels.
   5. Provide flame observation port opposite the burner.

C. Provide complete gas train including main gas valve, main pressure regulator, main shutoff cock, pilot gas
   valve, pilot pressure regulator, pilot cock and electronic flame supervision.

D. Control:
   1. Burner on/off low modulating control shall be by a unit-mounted micro-processor controller.
   2. On-board control package shall include flame supervision, integral prepurge timing combustion air
      proving switch and intermittent pilot with spark ignition.

2.5 REFRIGERATION SYSTEM

A. Compressor:
   1. Compressors shall be heavy-duty, hermetic scroll type with oil pump, suction and discharge line service
      valves, crankcase heater and inherent solid-state thermal overload protection.
   2. Each compressor shall have its own completely independent refrigeration circuit including sight-glass,
      filter-drier, manual shutoff valve and spring-tube high pressure relief valve.
   3. Compressors shall be isolated on spring isolators.
   4. Compressor capacity reduction shall be accomplished with variable capacity compressors with 10:1
      turn-down.

B. Condensing Coil:
   1. The condensing unit section shall be open on the sides to ensure complete access to and airflow through
      coils.
   2. Condenser coils shall be multi-row type fabricated from 3/8-inch O.D. seamless copper tubing
      mechanically bonded to rippled and corrugated aluminum fins.
   3. Condenser coil for each refrigerant circuit shall be provided with an additional circuit for a minimum of
      15 degrees of subcooling.
   4. Each condenser coil shall be factory leak tested at 200 psig under water.

C. Condenser Fans:
   1. Condenser fans shall be direct drive, propeller type designed for low tip speed and vertical air discharge.
   2. Fan blades shall be constructed of steel and riveted to an Iridite dipped steel center hub.
   3. Condenser fan motors shall be heavy-duty, inherently protected, 3-phase nonreversing type with
      permanently lubricated ball bearings and integral rain shield.

D. Evaporator Coil:
   1. Evaporator coils shall be multi-row type fabricated from 3/8-inch O.D. seamless copper tubing
      mechanically bonded to rippled and corrugated aluminum fins, with a maximum of 12 fins per inch.
   2. Coils shall be factory leak tested at 200 psig under water.
   3. The evaporator coil circuitings shall be fed with an adjustable thermal expansion valve (1 per refrigerant
      circuit) with an external equalizer.
   4. The evaporator coil shall be circuited for a row split.
E. Control:
   1. Each compressor circuit shall include a liquid line solenoid valve, oil pressure switch, high pressure switch, low pressure switch, and compressor control circuit switch.
   2. Each refrigeration circuit shall have at least 1 condenser fan controlled from an ambient thermostat for positive head pressure control.
   3. An ambient thermostat shall prevent the refrigeration system from operating below 50 degrees F.
   4. An adjustable 5-minute timer shall be provided for each compressor circuit to prevent short cycling.

F. Condensate Drain:
   1. A stainless steel primary drain pan shall be provided with the cooling coil and extend beyond the leaving side of the coil and underneath the cooling coil connections.
   2. The drain pan shall be connected to a threaded drain connection extended through the unit base.
   3. Manufacturer shall demonstrate that the unit is designed and constructed such that all overflow from the drain pan cannot enter the building when correctly installed on the curb and the overflow will instead spill onto the roof. Alternatively, a pre-wired water monitoring device in compliance with Paragraph 307.2.3.1 of the latest edition of the International Mechanical Code may be used.

2.6 FILTER SECTION

A. Housing:
   1. Provide galvanized steel filter housing as integral section of unit with access doors.
   2. Provide separate tracks for pre-filters and final filters.

B. Filters:
   1. As manufactured by Farr Company; or equal.
   2. Filters shall be slide-in style, requiring no supplemental clips, springs, or other hardware to maintain proper filter placement.
   3. Filter:
      a. Cartridge type with rigid frame.
      b. Synthetic, non-F media.
      c. High density micro-fine glass fiber media.
      d. 4-inch depth, MERV 10.
      e. 85% efficiency per ASHRAE Test Standard 52.
   4. Provide clogged filter switch with 24-volt dry contact.

2.7 ECONOMIZER SECTION

A. Configuration: Outside and return air section shall form a plenum with outdoor air introduced through horizontal intake hood complete with rain lip and bird screen.

B. Drainage: Floor of outdoor air section shall be sloped for water drainage.

C. Relief Damper:
   1. Provide a gravity relief damper in the return air section to exhaust air out of unit.
   2. Damper contact edges to be lined with urethane gasketing.

D. Outdoor and Return Air Dampers:
   1. Dampers shall be constructed of 14 gage galvanized steel and mounted on circular shafts for easy rotation.
   2. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers.
   3. The outside and return air dampers shall be sized to handle 100% of the supply air volume and arranged to converge the 2 air streams in a circular mixing pattern.
   4. Dampers shall be factory installed and wired. Controls shall be included with roof top unit.

E. Provide storm-proof louver or hood and bird screen to prevent infiltration.

F. Refer to the Drawings for economizer operating sequence.
2.8 ELECTRICAL

A. Wiring:
   1. Each unit shall be wired and tested at the factory before shipment.
   2. Wiring shall comply with NEC requirements and shall conform with all applicable UL standards.
   3. All wiring shall be number coded in accordance with the electrical wiring diagrams.

B. Components:
   1. All electrical components shall be labeled according to the electrical diagram and be UL recognized
      where applicable.
   2. Each unit shall have the following:
      a. A 115 volt control circuit transformer.
      b. System service switch and control circuit fuse.
      c. 115 volt GFCI receptacle that will remain energized when unit disconnect is open.

C. Overload Protection:
   1. All motor branch circuits shall be individually fused.
   2. Contactors and inherent thermal overload protection shall be furnished for each compressor and
      condenser fan motor.
   3. The supply air fan motors shall have contactors and external overload protection.

D. Control Panel:
   1. Main control panel shall be of weatherproof construction with a dead-front cover over the main power
      circuit controls.
   2. Furnish with integral latch/disconnect switch to cut power to unit before opening control panel door.
   3. A separate control panel shall house all controls for the refrigeration section.

E. Connections:
   1. A terminal block shall be provided for the power connection and a terminal board shall be provided for
      the low voltage control wiring.
   2. Knockouts shall be provided in the bottom of the main control panel for field wiring entrance.

2.9 ROOF CURB

A. Furnish in accordance with the requirements of Division 23 Section “Penetrations for HVAC”, “Wind Restraint
   Controls for HVAC”, and “Sound and Vibration Control for HVAC”.

B. Curb shall be a perimeter type with complete perimeter support for the air handling and refrigeration section.

C. Furnish gasketing material for field mounting between unit base and curb.

D. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor
   unit to the curb, and designed for loads at Project site. Comply with requirements in Division 23 Section "Wind
   Restraint Controls for HVAC" for wind-load requirements.

E. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors,
   and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind
   uplift requirements.

F. Roof curb will be furnished and installed by others. Coordinate installation of rooftop unit with curb installation.

G. Design of roof curb shall be by Thybar, or equal, to meet requirements in Division 23 Section “Penetrations
   for HVAC”, “Wind Restraint Controls for HVAC”, and “Sound and Vibration Control for HVAC”.
2.10 CONTROLS

A. Provide unit-mounted microprocessor-based control package to provide sequence of operation as described in Division 23 Section “Instrumentation and Control for HVAC.”
   1. Unit mounted control shall be capable of stand alone operation.
   2. Provide communication interface with building management system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that roof is ready to receive work, all auxiliary support steel is in place, and opening dimensions are as recommended by unit Manufacturer.

B. Verify that proper power supply is available.

3.2 SYSTEM CHECK

A. In addition to the requirements above, the Manufacturer's representative shall be on Site for a minimum of 1 day to demonstrate compliance with operational intent and Start-up Checklists.

3.3 INSTALLATION

A. Install in accordance with Manufacturer’s instructions.

B. Contractor shall verify that decay resistant shimmed wood blocking is level and square prior to installing roof curb.

C. Prior to lifting units onto curbs, Contractor shall install gasketing material (furnished by rooftop unit Manufacturer) along full curb perimeter and all around supply and return duct openings.

D. Units shall be lowered carefully onto curbs with equal overhang on 4 sides.

E. Curbs shall be installed so that top of curb is level. Installation shall be waterproof. Contractor shall verify that there are no excessive weld fillets in the corners of curb. All roof penetrations and flashings shall be completed in such a manner to ensure maintenance of roofing warranty. Curb perimeter shall be insulated.

F. Contractor shall do all necessary interconnecting of wiring and assembly of sections if the units are shipped in sections.

G. Provide installation accessories as detailed, including installing P-traps on all units.

H. Contractor to install plastic piping for condensate drain.

I. Contractor shall install outside air hoods (furnished with unit) according to Manufacturer’s instructions.

J. Air Cleaning: Refer to Division 23 Section “General HVAC Provisions” for construction period filter change requirements.

K. Unit Controls: Refer to Division 23 Sections “Instrumentation and Control for HVAC” and the sequence of operation on the Drawings.

L. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Division 23 Section "Wind Restraint Controls for HVAC" for wind-load requirements.
M. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.

END OF SECTION 23 74 43
SECTION 23 82 00 – CONVECTION HEATING 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. This Section includes, but is not necessarily limited to, the furnishing and installation of the major items listed below:
   1. Fin-tube radiation.

1.3 SYSTEM DESCRIPTION

A. All terminal heat transfer equipment shall be as indicated on the Drawings.

B. Manufacturer name and model number information given in equipment schedules represent quality and performance standards for that equipment.

C. Design performance for terminal heat transfer is based on the following:
   1. Heating:
      a. 60 degrees F entering air temperature.
      b. 180 degrees F entering water temperature.

1.4 SUBMITTALS

A. Manufacturer's Literature: For all equipment specified herein.
   1. General:
      a. Dimensions.
      b. Details of construction and installation.
      c. Name of Manufacturer.
      d. Model.
   2. For Each Device:
      a. Identify by equipment schedule tag number.
      b. Design capacity.
      c. Color.
      d. Electrical characteristics and project specific wiring diagrams including controls wiring.
      e. List of accessories furnished.

B. Operation and Maintenance Manuals: For powered equipment.
   1. Equipment function, normal operating characteristics and limiting conditions.
   2. Assembly, installation, alignment, adjustment and checking instructions.
   3. Operating instructions for start-up, routine and normal operating, regulation and control, and shutdown and emergency conditions.
   4. Lubrication and maintenance instructions.
   5. Guide to "troubleshooting".
   6. Parts lists and predicted life of parts subject to wear.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.
B. Manufacturer Qualifications: Regularly engaged in production of such equipment.

PART 2 - PRODUCTS

2.1 FIN-TUBE RADIATION

A. Manufacturers:
1. Trane.
2. Vulcan Radiator Corporation.

B. Heating Elements:
1. Seamless copper tubing mechanically expanded into evenly spaced aluminum fins.
2. Ends suitable for solder joints.
3. 150 psig working pressure at 150 degrees F.

C. Enclosure:
1. Minimum 22 gage steel with back and top of 1 piece, front panel, end caps, corners and joiner pieces to snap together and front panel easily removable.
2. Support enclosure on continuous channel with dirt-sealing gasket.
3. 18 gage galvanized steel element brackets to support front panel and noise element cradle.
4. Style as indicated on the Drawings.
5. Color to match wall.

D. Accessories: Provide all necessary hangers, end caps, corners, sleeves, wall trips and valve compartments where required for complete installation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. In accordance with Manufacturer's installation instructions and installation details indicated on Drawings.

B. Thoroughly clean all exposed equipment pieces.

C. Vacuum clean all heating/cooling elements prior to job acceptance.

3.2 COORDINATION

A. Coordinate with Temperature Control Subcontractor to verify proper operating sequence for all units with factory installed controls which interface with the building temperature control system.

B. Coordinate with Electrical Subcontractor for power supply to units equipped with fans.

END OF SECTION 23 82 00
SECTION 23 83 19 – RADIANT CEILING HEATING AND COOLING 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 furnishing and installation of radiant ceiling panel system.

1.3 SYSTEM DESCRIPTION

A. Linear extruded radiant heating elements using hot water as the heating medium and installed at the perimeter of the ceiling plane.

1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. Minimum heat output of 340 Btuh per lineal foot of panel based on:
   1. 24-inch panel width.
   2. 160 degrees F mean water temperature.
   3. 72 degrees F room air temperature.
   4. 70 degrees F average unheated surface temperature.

1.5 SUBMITTALS

A. Shop Drawings: In the form of reflected ceiling Drawings with details showing:
   1. Radiant ceiling panels in relation to adjacent ceiling and other construction.
   2. Conditions at abutting, intersecting, and penetrating construction.
   3. Dimensional locations of lighting fixtures, diffusers, sprinkler heads, and other items that pierce the ceiling plane.

B. Product Data:
   1. Manufacturer’s descriptive literature marked to indicate products proposed.
   2. Published panel performance curves and capacity ratings based on testing done or confirmed by a recognized testing laboratory.
   3. System installation details and instructions.

C. Samples:
   1. Radiant panel assembly approximately 12 inches long.
   2. Suspension system parts including trim, each piece being at least 12 inches long.

D. Certificates:
   2. Certification that current published performance and capacity data on radiant panels are based on panels of a model that has been in continuous use for not less than 3 years.

E. Operation and Maintenance Data:
   1. Operation and maintenance of system.
   2. Cleaning and maintenance of finished panel surfaces.
1.6 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed Shop Drawings.
   3. Authorized by Manufacturer to perform the Work.

B. Provide Manufacturer's field services.

1.7 DELIVERY, STORAGE AND HANDLING

A. All materials shall be delivered in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter and damage by weather or elements in accordance with Manufacturer’s directions.

C. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Airtex, Frenger; or equal.

2.2 MANUFACTURED UNITS

A. Extruded aluminum with white finish vee-groove surface.

B. 1/2-inch I.D. copper tubes.

C. Backed by 1-inch thick, glass fiber insulating blanket.

2.3 ACCESSORIES

A. Provide all channel clips, connecting tubing, return bends and special tools required for proper installation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Identify space conflicts before installing any of the work.

B. Consult with other trades as to the exact location and level of piping, ductwork, electrical and other work which may interfere with panels.

3.2 INSTALLATION

A. Install panels in conformance with:
   1. The Shop Drawings reviewed by Engineer.
   2. The Manufacturer’s recommendations.
3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Arrange and pay for Manufacturer's engineer to provide the services indicated below for a minimum onsite time: 1 day. Schedule the following as soon as practicable after installation and at times approved by Engineer and Owner.

B. Manufacturer’s Engineer: Check work, promptly make all changes and additions required by Manufacturer’s engineer.
   1. Manufacturer’s Engineer: Assist in start-up, demonstrate operation and maintenance to Owner’s personnel, and review operation and maintenance manual with Owner’s personnel.

C. Submit Manufacturer’s engineer’s written approval of installation.

3.4 CLEANING

A. Clean, flush and test piping in accordance with Manufacturer’s recommendations and Division 22 Section “Testing and Cleaning of Plumbing Systems” and Division 23 Section “Testing and Cleaning of HVAC Systems,” prior to final connection to the heating water supply and return piping.

B. Clean all exposed surfaces.

END OF SECTION 23 83 19
SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   5. Duct seal.
   6. Common electrical installation requirements.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with
   1. NECA 1 - Standards Practices for Good Workmanship in Electrical Construction.
   2. NEC – National Electrical Code (NFPA 70)

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration, damage, contamination with foreign matter, and damage by weather or elements, and according to Manufacturer's directions.

C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, weather tight wrapping.

D. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

1.6 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, and cable trays 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. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Sections.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES
   A. Sleeves for Rectangular Openings: Galvanized sheet steel.
      1. Minimum Metal Thickness:
         a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
         b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 GROUT
   A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.3 DUCT SEAL
   A. Description: UL listed, pliable, non-hardening, non-corrosive, weather-proof putty material, designed as a moisture barrier for weather-sealing service entries, electrical cables, and conduit ducts.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Amco Corp. - Hydra-Seal
         b. Ilsco Corp. – DS Duct Seal
         c. JM Clipper - Duxseal
         d. OZ/Gedney Co. – DUX
         e. RectorSeal - Duct Seal Compound
         f. Thomas & Betts Corp. - DX.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION
   A. Comply with NECA 1 and NEC.
   B. 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.
   C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in a manner as to facilitate future disconnecting with minimum interference with other items in the vicinity.
   D. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS
   A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
   B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
   C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless otherwise indicated on the Drawings.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section “Joint Sealants.”

3.3 Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Sections.

3.4 SLEEVE-SEAL INSTALLATION

A. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 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 Division 07 Sections.

END OF SECTION 26 05 00
SECTION 26 05 20 – CONDUCTORS AND CABLES – 600V AND BELOW

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 furnishing and installation of all electrical conductors, cables, splices, and connectors.
   B. Major Systems Include:
      1. 600V and below feeders and electrical distribution.
      2. Branch circuit wiring.

1.3 REFERENCES
   A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the standards of the following organizations as applicable to materials, construction and testing of wire cables:
      1. NEMA - National Electrical Manufacturer Association Standards.
      2. IEEE Standards.
      3. Insulated Cable Engineers Association - Standards.
      4. ASTM Standards.
      5. NEC - National Electric Code

1.4 QUALITY ASSURANCE
   A. Fabrication and Installation Personnel Qualifications:
      1. Trained and experienced in the fabrication and installation of the materials and equipment.
      2. Knowledgeable of the design and the reviewed submittals.
   B. Manufacturers: Firms regularly engaged in the manufacture of electrical conductor and cable products of the types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.5 DELIVERY, STORAGE AND HANDLING
   A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
   B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer’s directions.
   C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.
   D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.
PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Except as otherwise indicated, provide conductors, cables, and connectors of Manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by the Manufacturer and as required for the installation.

B. Power Wire:
   1. All conductors and cables shall be new with a minimum wire size of No. 12 AWG. Manufacturer's name, type, and size shall be permanently marked on the outer covering at regular intervals and delivered in complete coils or reels.
   2. Provide factory fabricated conductors of size, rating, material, and type as indicated for each service. Where not indicated, provide proper selection as determined by installer to comply with installation requirements and with NEC standards, from only following types and conductors:
      a. Type THHN/THWN, 600 Volt, 75/90 Degrees C Rated with Nylon Jacket: Stranded copper for all sizes.
      b. Bare Conductors: Stranded copper for all sizes.

C. Control Cable: No. 14 AWG minimum, type THHN/THWN, plenum rated.

D. Power Wiring Cable Accessories: For Connectors:
   1. Wing nuts by Ideal.
   2. Stan-Kon by Thomas & Betts.
   4. Compression Type 53200 by Thomas & Betts.
   5. Hydent by Burndy.
   6. Insulated multi-cable mechanical connector blocks by Polaris, or Ilsco.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install electrical conductors, cables, and connectors as indicated on the Drawings, in accordance with the Manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation" and in accordance with recognized industry practices to ensure that products serve the intended functions.
   2. Conductors and cables shall be sized in accordance with the Drawings or, in the absence thereof, in accordance with NEC requirements. Except and indicated herein, conductor sizes greater than No. 12 AWG are indicated on the Drawings.
   3. Provide dedicated ungrounded conductor (neutral) for each 20A, 120V circuit.

B. Voltage Drop Compensation:
   1. Provide No. 10 AWG conductors in lieu of No. 12 AWG conductors to compensate for voltage drop as follows:
      a. For each 277V, 20 ampere branch circuit that exceeds 200 feet in length between the branch circuit panelboard and the last outlet.
      b. For each 120V, 20 ampere branch circuit that exceeds 100 feet in length between the branch circuit panelboard and the last outlet.
   2. When conductor size is increased to compensate for voltage drop, provide equipment grounding conductor increased in size in accordance with NEC.

C. Installation Procedures:
   1. Install interior conductors after building is enclosed and water tight.
   2. Each conduit shall be free of moisture and debris before conductors are installed.
   3. Remove moisture from conduits by swabbing.
   4. Install conductors so insulation is not damaged. Replace all conductors that are damaged.
5. Install conductors and cables only in code conforming raceway.
6. Pull conductors together where more than 1 conductor is being installed in a raceway.
7. Use heat shrink tubing for all instrument signal cable terminations.
8. Use manufacturer-approved pulling compound or lubricant, where necessary. Compound shall not deteriorate conductor and insulation. Compounds shall be UL listed.
9. Use a pulling means, including fish tape, cable or rope, and basket-weave wire/cable grips, that will not damage the raceway or the wire.
10. Keep conductor splices to a minimum.
11. Install splices and taps which have equivalent or better mechanical strength and insulation as the conductor.
12. Use splice and tap connectors which are compatible with the conductor material.
13. Make all joints, splices, and connections only at accessible junction or outlet boxes, never inside conduit or fitting. Make splices in No. 10 AWG and smaller wire with insulated spiral mechanical connectors.
14. Make splices in No. 8 AWG and larger copper wire with compression type mechanical connectors.
15. All splices located in handholes and wet locations shall be rated for wet locations.
16. Insulate all joints at splices with “Scotch” brand electrical pressure sensitive tape to 150% of conductor insulation value.
17. Make conductor length for parallel feeds identical.
18. Where exposed cables are installed, cables shall be installed parallel and perpendicular to exposed structural members and building lines.
19. Do not lace, strap or tie feeder or branch circuit conductors together in panels, switchboards, variable speed drives, motor control centers, automatic transfer switches, boxes, and wireways.
20. Feeders and service entrance conductors entering electrical equipment shall be adequately secured with cable cleats.
21. Use color coded conductors as follows:
   a. Phases: Black-red-blue (under 150V to ground).
   b. Phases: Brown-orange-yellow (over 150V to ground).
   c. Neutral: White identified (feeders); White (branch circuits).
   d. Ground: Green identified (feeders); Green (branch circuits).
22. Support conductors in vertical raceways in accordance Division 26 Section “Hangers and Supports for Electrical Systems.”
23. Outlets:
   a. Leave at least 6 inches of free conductor at all outlets except where conductors are intended to loop without joints through outlets for fixtures or wiring device hook-ups.
   b. Free ends and loops at boxes and enclosures shall be pushed back into boxes and protected by blank cover plates or other means until interior painting and decorating work is completed.
24. Lights and outlets shall be grouped on circuits as indicated on the Drawings. Different types of circuits such as feeders, branch circuits, control circuits, and signal circuits, shall not be mixed in common conduit runs, but shall be run separately, although more than 1 circuit of the same system may be run in common conduit runs.
25. Fire Alarm Circuits: Power limited, fire-protective signaling circuit cable in raceway, cable tray or conduit.

### 3.2 FIELD QUALITY CONTROL

#### A. General:
1. Prior to energization, check conductors and cables for continuity of circuitry and for short circuits. Correct malfunctions when detected.
2. Subsequent to conductor and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements.

END OF SECTION 26 05 20
SECTION 26 05 27 – GROUNDING AND BONDING

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 furnishing and installation of a complete and continuous grounding system.

1.3 DESIGN AND PERFORMANCE REQUIREMENTS

A. All equipment, raceway systems, interior wiring systems with neutrals, receptacles, and power outlets, motors and motorized equipment shall be grounded.

1.4 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design.

B. Grounding system shall be in accordance with the current National Electrical Code.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: A portion of the required materials for grounding systems are specified in the Division 26 – Electrical Sections.

B. Connectors:
   1. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions as manufactured by Thomas and Betts; or equal.
   2. Irreversible Compression Connectors: Compression connections shall be irreversible, cast copper, high conductivity as manufactured by Thomas and Betts; or equal.

PART 3 - EXECUTION

3.1 POWER SYSTEM GROUNDING

A. Make cable to rod and cable to cable connections by using exothermic-welding process, or irreversible compression type connectors made for direct burial.

B. Irreversible compression connectors shall be factory filled with an oxide inhibitor and installed with the connector manufacturer's die such that the die index matches the listed index on the connector. Connectors shall be fully crimped with a 14 ton or larger hydraulic tool such that the index number is embossed on the connector. Irreversible compression connectors may be used in below grade, above grade, building steel, electrode connections and concrete encased applications. Connectors shall comply with IEEE 837, UL467 and CSA22.2.

3.2 DISTRIBUTION SYSTEM GROUNDING

A. Circuit Grounding: Install grounding bushings, grounding studs, and grounding jumpers at distribution centers, pull boxes, and panelboards.
B. Bonding Jumpers:
   1. Provide green insulation, size correlated with overcurrent device protecting the wire, attached to
      grounding bushings on conduits, to lugs on boxes, and other enclosures.
   2. Bond to neutral only at service neutral bar.

C. FMC and LTFMC: Install separate grounding conductor in FMC and LTFMC. Connect each end to a grounding
   bushing.

D. Receptacles and Power Outlets: Ground receptacles and power outlets to the conduit system with a Type
   THHN green grounding conductor sized in accordance with NEC Article 250 and connected between the
   device grounding screw and outlet box.

E. Metallic Conduit: When grounding conductors are enclosed in metallic conduit, the conduit shall be bonded
to the grounding conductors at both ends.

F. Ground motor bases and frames by pulling a separate conductor in with the motor feeder.

G. Expansion Joints: Install a bonding jumper around expansion fittings in metallic conduit to maintain ground
   continuity.

H. Separately Derived Systems: Grounding of separately derived systems, i.e., secondary transformers, shall
   be in accordance with NEC, Article 250. Use suitable ground lugs and clamps approved for this purpose.

END OF SECTION 26 05 27
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 furnishing and installation of the following:
   1. Hangers and supports for electrical equipment and systems.

1.3 DEFINITIONS

A. Electrical Supports: Angles, channels, brackets, and mounting accessories for supporting all conduit, luminaires, switches, and other electrical equipment which are hung or mounted above floor.

1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. This Section defines general criteria for the selection and installation of supporting devices, but does not cover all types specifically required for the Project.

B. Choose or design supporting devices in accordance with these general criteria.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed submittals.

B. Regulatory Agencies Requirements:
   1. Provide supporting devices listed by Underwriters' Laboratory for their application as installed.
   2. Comply with National Electrical Code (NFPA 70) as applicable to construction, installation, and requirements for supporting devices.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer’s directions.

C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.

D. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Conduit Supports:
1. Single Runs: Galvanized conduit straps or ring bolt type hangers with spring clips. Do not use plumber’s perforated straps.
2. Use fiberglass supports in the mechanical room areas. Hardware used in the mechanical rooms shall be stainless steel.
3. Multiple Runs: Conduit rack with 25% spare capacity.
4. Vertical Runs: Channel support with conduit fittings.
5. Manufacturers:
   a. Cooper B-Line; a division of Cooper Industries
   b. ERICO International Corporation.
   c. Allied Support Systems; Power-Strut Unit.
   d. GS Metals Corp.
   e. Michigan Hanger Co., Inc.; O-Strut Div.
   f. National Pipe Hanger Corp.
   g. Thomas & Betts Corporation.
   h. Unistrut; Tyco International, Ltd.
   i. Wesanco, Inc.
   j. Or equal.

B. Mounting, Anchoring, and Attachment Components
1. 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 where used.
2. 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.
3. Manufacturers:
   a. Hilti, Inc.
   b. ITW Construction Products.
   c. MKT Fastening, LLC.
   d. Or equal.

C. Supports for Conductors in Vertical Conduit:
1. Install in compliance with NEC article 300.19.
2. Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored 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 malleable iron.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Layout to maintain headroom, neat mechanical appearance, and to support equipment loads.
2. Secure Engineer's approval before welding or bolting to steel framing or anchoring to concrete structure.
3. Where equipment is to be suspended from cast-in-place concrete construction, set approved concrete inserts in formwork to receive hanger rods. Where equipment is to be suspended from metal deck and beam or joist construction, support equipment from beams or joists only.

END OF SECTION 26 05 29
SECTION 26 05 34 – 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 furnishing and installation of conduits and fittings for electrical wiring.

1.3 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design.

B. Regulatory Agencies Requirements:
   1. ACI – American Concrete Institute – Standards pertaining to conduits embedded in concrete (Section 6.3 in ACI 318 – Building Code Requirements for Structural Concrete and Section 6.3 in ACI 350R – Environmental Engineering Concrete Structures.)
   2. NEMA – National Electrical Manufacturer's Association – Standards pertaining to raceways.
   3. NEC – National Electric Code – As applicable to construction and installation of conduit system.
   4. Provide conduit which is listed and labeled by Underwriters' Laboratories.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration or damage (e.g., bending, end damage, finish scoring), contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.

C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping. Provide color coded end cap thread protectors on exposed threads of threaded metal conduit.

D. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Rigid Steel Conduit (RSC): Galvanized steel, heavy wall conduit with threaded fittings, 1/2-inch trade size minimum, insulated bushings.

B. Electrical Metallic Tubing (EMT):
   1. Thin wall, hot galvanized, steel tubing, 3/4-inch trade size minimum with insulated throat steel connector.
   2. Fittings: Steel Compression (die cast fittings are expressly prohibited).
C. Surface Metal Raceway (SMR):
1. Two-piece steel raceway including a base and snap-on cover. Manufacturer: Wiremold, or equal. Provide type as indicated on the drawings.
2. UL listed.
3. Fittings, couplings, junction boxes, and accessories as required. Color to match raceway.
4. Provide all necessary components for a complete, functioning, SMR system, including fittings, devices, straps, etc for line voltage and low voltage components.

D. Flexible Metal Conduit (FMC): 1/2-inch trade size minimum with galvanized steel flexible conduit insulated throat steel connectors.

E. Liquid Tight Flexible Metal Conduit (LTFMC): 1/2-inch trade size minimum with galvanized steel flexible conduit with flexible, moisture-proof PVC jacket and liquid tight connectors.
1. In the mechanical room areas, LTFMC fittings shall be PVC coated.

F. PVC Coated RSC:
1. Galvanized RSC with a minimum of 40 mil PVC exterior coating and 2 mil urethane internal coating.
2. Manufacturers:
   a. Robroy Industries: Plasti-Bond RED.
   c. OCAL, Inc.: OCAL-BLUE.
3. All fittings, conduit bodies, outlet boxes, and accessories shall be products of the same Manufacturer and shall be coated with a minimum of 40 mil PVC exterior coating and 2 mil urethane internal coating.
4. Finished conduit shall fully conform to the current NEMA Standard RN-1 and shall have a label affixed indicating compliance with UL Standard No. 6.

G. Joint Compound for RSC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

H. Conduit Hubs for RSC:
1. Suitable for environment served.
2. Grounding screw.
3. O-ring gasket.
4. Material: stainless steel Type 316.
5. Manufacturer:
   a. Cooper Myers Hubs.
   b. Thomas & Betts.
   c. Killark.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Unless otherwise specified or indicated on the Drawings, conceal conduit to the extent possible.
1. In finished areas where conduit cannot physically be concealed due to existing conditions, provide surface metal raceway. Finished areas are generally, but not always: above grade, heated spaces with finished walls (e.g., painted, drywall, etc.), finished floors (e.g., painted concrete, carpet, tile, etc.), and finished ceilings (e.g., drywall, suspended ceiling grids, wood, etc.).
2. Conduit shall not be concealed within tank walls, slabs, or ceilings.
3. Do not conceal conduit in Corrosive Locations.

B. Exposed conduit permitted in:
1. Mechanical and Electrical equipment rooms.
2. Rooms without finished ceilings (overhead only).
3. Unfinished rooms.
C. Install conduit products in accordance with:
   1. The Manufacturer's written instructions.
   2. Applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation."
   3. Recognized industry practices to ensure that products serve intended function.

D. Conduit Joints: Cut square, reamed smooth and drawn up tight.

E. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joint. Follow compound manufacturer’s written instructions.

F. Bends:
   1. Number per run for conduit that support feeder and branch circuits: Do not exceed the equivalent of 4 quarter bends (360 degrees) between pull points.
   2. Number per run for conduit that supports data/communications cabling: Do not exceed the equivalent of 2 quarter bends (180 degrees) between pull points.
   3. Make bends and offsets so as not to reduce the inner diameter of the conduit.
   4. To the extent possible, avoid using large junction boxes as 90 degree junctions.

G. Routing:
   1. Concealed Conduits: Run in a direct line with long sweep bends and offsets.
   2. Exposed Conduits: Run parallel to, and at right angles to, building lines.
   3. Run continuous from outlet to outlet and from outlets to cabinets, pull or junction boxes.
   4. Secure to all boxes and cabinets with locknuts and bushings in such a manner that each system is electrically continuous throughout.

H. Cap conduit ends to prevent entrance of foreign materials during construction.

I. Provide insulated bushings on all threaded conduit run terminations and where entering the bottom of open-bottom switchboards, transformers, and similar equipment.

J. Where entering the bottom of open-bottom equipment (i.e., switchboards, panelboards, transformers, and similar equipment) conduit shall not be installed flush with the floor/equipment pad and shall not rise more than 3 inches above the bottom of the enclosure.

K. Conduit entering control panels shall not obstruct internal components and shall allow for neat and workmanlike wire management.

L. Completely install all conduit systems before installing conductors.

M. Support:
   1. Adequately support conduit from structural elements of the building.
   2. Do not drill or tap structural building steel without approval from Engineer.
   3. Do not rest conduit on, nor support it from, ceiling suspension systems, ceiling tiles or mechanical equipment including, but not necessarily limited to ductwork and fans.
   4. Conduit shall be supported in accordance with the NEC and Division 26 Section “Hangers and Supports for Electrical Systems."

N. Provide conduit expansion couplings where conduits cross building or structure expansion joints.

O. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200 pound (90 kg) tensile strength. Label and leave at least 12 inches of slack at each end of pull wire.

P. FMC and LTFMC Installation:
   1. Provide separate grounding conductor in accordance with Division 26 Section “Grounding and Bonding.”
   2. Connection to light fixtures shall not exceed 6 feet in length within an accessible ceiling and 3 feet in length where exposed. Connection to solenoids, pressure switches, motors, fans, HVAC equipment, and similar equipment shall not exceed 3 feet in length.
Q. PVC Coated RSC Installation:
1. Install in accordance with Manufacturer’s published installation guide, National Electrical Code, local codes and standard trade practices.
2. Use Manufacturer’s recommended pipe wrenches, clamping devices, benders, and threading tools.
3. Provide PVC coated fittings at each termination point.
4. Field threads shall be degreased and coated with Manufacturer’s recommended compounds.
5. Provide separate grounding conductor in accordance with Division 26 Section “Grounding and Bonding.”
6. Take care not to damage PVC coating during assembly, cutting, bending, clamping, and threading.
7. Use Manufacturer's approved touch-up compound to repair nicks and cuts to the outer PVC jacket, and for use as a sealant. Where large abrasions are made in the outer PVC jacket the conduit shall be replaced.

R. Firestopping: Firestop all conduit penetrations of fire rated barriers by using approved material to ensure integrity of the rating

3.2 CONDUIT SCHEDULE

A. Feeders, Branch Circuits and System Conduits:
1. Above Slab or Grade:
   a. Exposed Conduit Below 10'-0" AFF: RSC or IMC where subject to physical damage. EMT where not subject to physical damage.
   b. Exposed Conduit Above 10'-0" AFF: EMT.
   c. Concealed In Walls: EMT or FMC.
   d. Concealed Above Ceiling: EMT.
   e. Corrosive Locations (Mechanical Rooms): PVC coated RSC.

B. Data/communications conduits in dry locations not subject to physical damage and not installed underground or in or below concrete: EMT.
1. Data/communication conduits shall be bonded.
2. Data/communication sleeves, provide plastic bushings.
3. Data/communication conduits shall be 3/4-inch minimum.

C. Connection To Equipment:
1. Lighting Fixtures and Control Devices (including, but not necessarily limited to solenoids, pressure switches, and field instruments):
   a. Dry Locations: FMC.
   b. Wet or Damp Locations: LTFMC.
   c. Corrosive Locations (Mechanical Rooms): LTFMC with PVC coated fittings.
2. Vibrating Equipment (including, but not necessarily limited to motors and transformers):
   a. Motors:
      1) Dry Locations: FMC.
      2) Wet or Damp Locations: LTFMC.
      3) Corrosive Locations (Mechanical Rooms): LTFMC with PVC coated fittings.
   b. Transformers at Dry Locations: FMC.

D. Provide separate raceway systems for:
1. Normal power wiring.
2. Emergency power wiring.
3. Data/communication wiring.
4. Fire alarm system wiring.
5. A.C. signal and control wiring.
6. Low voltage signal and control wiring.

END OF SECTION 26 05 34
SECTION 26 05 35 – 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. This Section includes the furnishing and installation of all electrical boxes and the major items listed below:
   1. Outlet boxes.
   2. Junction boxes.
   3. Pull boxes.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. NEMA - National Electrical Manufacturer's Association: Standards as applicable to nonmetallic fittings for underground installation.
   2. NECA - National Electrical Contractor's Association's: Applicable portions of "Standard of Installation".

1.4 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed submittals.

B. Regulatory Agencies Requirements:
   1. Provide boxes which are listed and labeled by Underwriters’ Laboratories.
   2. NEC - National Electrical Code (NFPA 70) - As applicable to construction and installation of electrical boxes.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer’s directions.

C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.

D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Interior Outlet Boxes:
1. Galvanized steel outlet boxes of the type, shape, and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.
2. In areas requiring exposed RNMC, provide nonmetallic outlet boxes of type, shape and size to suit each location. Each box is to have conduit hubs with removable plugs and a non-metallic cover. Each box shall be compatible with RNMC.

B. Interior Outlet Box Accessories:
1. As required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps, and metal straps for supporting outlet boxes. Accessories shall be compatible with outlet boxes being used and meet the requirements of individual wiring situations.
2. Choice of accessories is installer's option.

C. Weatherproof Outlet Boxes: Corrosion-resistant cast metal, weatherproof outlet boxes, of the type, shape, and size, including depth of box, suitable for each application, with threaded conduit ends.

D. For Ceilings: 4-inch octagonal boxes for receiving 3 or less 1/2-inch conduits.

E. For Flush Mounting In Walls:
1. 4-inch square boxes with matching plaster cover for single or 2 gang outlets.
2. For larger boxes use solid type or special units.
3. In masonry, use deep boxes.

F. Surface Mounted: 4-inch square.

G. Junction and Pull Boxes: Sheet steel junction and pull boxes, with screw-on covers; of the type and shape and size to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers. Dry interior location boxes shall have baked enamel finish. Damp location and exterior boxes shall have galvanized finish.

H. Flush Mounted Pull Boxes: Provide overlapping covers with flush-head cover retaining screws, prime coated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Install electrical boxes as indicated, in compliance with NEC requirements and in accordance with the Manufacturer’s written instructions and recognized industry practices to ensure that the boxes and fittings serve the intended purposes.
2. Provide weatherproof outlet boxes for interior locations exposed to weather or moisture.
3. Provide knockout closures to cap unused knockout holes where blanks have been removed.
4. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.
5. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.
6. Mount outlet boxes flush in areas other than mechanical rooms, electrical rooms, and above removable ceilings.
7. Adjust position of outlets in finished masonry walls to suit masonry course lines.
8. Do not install boxes back-to-back in same wall. Coordinate cutting of masonry walls to achieve neat openings for boxes.
9. Do not use sectional or handy boxes unless specifically requested.
10. For boxes mounted in exterior walls install insulation behind outlet boxes to prevent condensation in boxes.
11. For outlets mounted above counters, benches, and splashbacks, coordinate location and mounting heights with built-in units. Adjust outlet mounting height to agree with required location for equipment served.

12. Outlet boxes in finished areas shall be located as indicated on the Drawings and so set that the face plates will be flush with the finish on which it is mounted. Where 2 or more devices of any kind are set side by side, set them in gang boxes unless otherwise noted on the Drawings.

13. Locate pull boxes and junction boxes above removable ceilings or in electrical rooms, utility rooms, or storage areas such that boxes will be accessible after completion of building.

14. All boxes shall have covers installed at completion of construction.

END OF SECTION 26 05 35
SECTION 26 05 53 – 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. This Section includes the furnishing and installation of proper identification for electrical system components.

B. Items requiring identification or labeling include:
   1. Cables and conductors.
   2. Conduit systems.
   3. Controls:
      a. Motor starters.
      b. Variable frequency drives.
   4. Distribution Equipment:
      a. Disconnect switches.
      b. Enclosed circuit breakers.
      c. Switchboards.
      d. Transformers.
      e. Panelboards.
   5. Fire alarm system equipment.

1.3 SUBMITTALS

A. Nameplate schedule identifying each device to be labeled and project specific label text.

PART 2 - PRODUCTS

2.1 ELECTRICAL LABELS

A. Provide engraved laminated plastic nameplate to identify each piece of electrical equipment:
   1. Nameplate shall have 3/8-inch minimum black letters on a white background.
   2. Punched or drilled for mechanical fasteners.

B. Provide printed labels by Brady or T&B to identify conductors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Attach nameplates directly to each piece of electrical equipment. In finished areas of building, install nameplates behind enclosure door where possible.
   2. Where several conductors pass through a pull box, junction box, or enclosure, provide wire labels. Group wires before labeling.

B. Cables and Conductors: In accordance with Division 26 Section “Conductors and Cables – 600V and Below.”

C. Conduit Systems:
   1. Junction boxes used for fire alarm system wiring shall be red.
   2. Provide label inside each junction and pull box identifying circuit numbers for all conductors contained inside the box. Labeling shall be printed neatly with permanent, waterproof, black ink marker.
D. Controls: For each of the following control devices, provide label attached to enclosure cover. Label shall identify:
1. Motor Starters: Name of equipment served and load (example, “EF-5, 5 HP”).
2. Variable Frequency Drives: Name of equipment served and load (example, “P-1, 25 HP”).

E. Distribution Equipment: For each of the following pieces of distribution equipment, provide label attached to enclosure cover. Label shall identify:
1. Disconnect Switches: Name of equipment served, number of poles, ampere rating/fuse size (where applicable), and load (example, “RTU-1, 3P30/25, 8 TON”).
2. Enclosed Circuit Breakers: Name of device as indicated on one line diagram, number of poles, and circuit breaker size (example, “MCB, 3P200”).
3. Switchboards:
   a. Name of device as indicated on one line diagram and voltage-phase (example, “MSWBD, 480Y/277V-3Ø”).
   b. Provide label near each feeder/branch breaker identifying name of equipment served, number of poles, and circuit breaker size (example, “TRANSFORMER T-LPA, 3P80”).
4. Transformers: Name of device as indicated on one line diagram, KVA rating, primary voltage: secondary voltage, source transformer is fed from, and load transformer feeds (example, “T-LPA, 45 KVA, 480:208Y/120V, FED FROM MSWBD, FEEDS PANEL LPA”).
5. Panelboards:
   a. Name of device as indicated on one line diagram, voltage-phase, and area served (example, “LPA, 208Y/120V-3Ø, First Floor Lighting”).
   b. Equip interior of enclosure door with a circuit directory frame, typewritten card, and clear plastic cover. Directory shall identify load description for each circuit, including spares. Hand lettering is not acceptable.

F. Fire Alarm System Equipment: Provide label attached to enclosure cover. Label shall identify name of device as indicated on fire alarm system riser diagram or electrical drawings (example, “FIRE ALARM CONTROL PANEL”).

END OF SECTION 26 05 53
SECTION 26 09 23 – 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. This Section includes the furnishing and installation of all lighting control devices listed below:
   1. Occupancy sensors (wall and ceiling mounted) and related power packs.
   2. Photo sensors (daylight harvesting).
   3. Time clocks.
   4. Ballast load transfer control relay devices (UL924).

1.3 SUBMITTALS

A. Shop Drawings: Provide the following information for each type of lighting control device.
   1. Name of Manufacturer.
   2. Model number.
   3. Details of construction and installation.
   4. Assembly drawings, including elevations, plans, sections, and dimensions.
   5. Project Specific Point-To-Point Wiring Diagrams:
      a. Diagrams shall clearly identify all field wiring requirements.
      b. Connection points shall be identified by terminal number.
   6. Project specific floor plans, including all occupancy sensor types, photo sensor type locations, as recommended by Manufacturer.
   7. Color and finish.
   8. Options and accessories.

B. Installation Instructions: For lighting control devices.

C. Manufacturer’s Certification: For lighting control devices:
   1. Sworn statement that the equipment furnished complies with this Specification.
   2. Written approval of installation.

D. Installation and Maintenance Manuals: For lighting control devices.
   1. Equipment function, normal operating characteristics, and limiting conditions.
   2. Assembly, installation, alignment, adjustment, and checking instructions.
   3. Operating instructions for start-up, routine and normal operating, regulation and control, shutdown, and emergency conditions.
   5. Guide to “troubleshooting.”
   6. Parts list and predicted life of parts subject to wear.
   7. Project specific outline and cross-sections, assembly drawings, engineering data, and wiring diagrams.
      Wiring diagrams shall reflect final, as-installed conditions and include wire numbers.
   8. Test data and performance curves.

1.4 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed submittals.
B. Manufacturer:
   1. At least 5 years experience with approved systems.
   2. Provide Owner training on system operation.

C. Components: All equipment shall be UL listed.

1.5 WARRANTY

A. In accordance with the warranty provisions defined in the General Conditions and Supplementary Conditions: Includes all lighting control systems.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.

C. Store materials indoors and protect from weather.

D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected material with new material at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Occupancy Sensors:
   1. Lutron.
   2. Wattstopper.
   3. Hubbell.
   4. Sensor Switch.
   5. All occupancy sensors shall be produced by the same Manufacturer.

B. Ballast Load Transfer Control Relay Devices (UL924):
   1. Nine 24, Inc.
   2. The Bodine Company.
   3. LVS, Inc.
   4. Lithonia.

C. Photo Sensors (Daylight Harvesting):
   1. Leviton.
   2. Lutron.
   3. Wattstopper.
   4. Hubbell.
   5. Steinel.
   6. All photo sensors shall be produced by the same Manufacturer and shall be compatible with control equipment.

D. Time Clocks:
   1. Intermatic
   2. Paragon.
   3. Tork.

2.2 MATERIALS

A. General: Furnish and install lighting control devices as indicated on the Drawings.
B. Low Voltage Wiring:
1. For low voltage wiring, provide wire type as recommended by the Manufacturer.
2. Adhere to manufacturer's recommendations as to maximum wire length and maximum quantity of relays per switch.

C. Line Voltage Wiring: No. 12 AWG minimum.

D. Occupancy Sensors:
1. Provide occupancy sensors as indicated herein and on the Drawings.
2. System Components:
   a. Ultrasonic occupancy sensors.
   b. Passive infrared occupancy sensors.
   c. Dual technology occupancy sensors.
   d. All Occupancy Sensors Shall Include:
      1) Self adjusting type based on algorithm for maximum performance Adjustable time delay 30 seconds to 15 minutes.
      2) Adjustable unit sensitivity.
      3) UL and CBA listed.
      4) 5 year warranty.
      5) Mounting brackets or boxes as required for each space application.
   e. Each Ceiling Mounted Sensor Shall Include:
      1) Power pack and/or slave packs as required.
      2) Additional isolated relay contact for use by the room mechanical systems.
      3) Manual off override if indicated.
      4) LED indicates motion detection.
   f. Device quantities and locations as indicated on the Drawings.
   g. Wiring: As indicated on the Drawings.

E. Ballast Load Transfer Control Relay Device (UL924):
1. Ballast load transfer control relay device shall operate as follows:
   a. Unit shall comply with NEC and UL924.
   b. Unit operates automatically on a continuous standby mode.
   c. Unit bypasses any electrical control device.
   d. Unit switches load to back-up power when normal power fails with no possibility of current crossover.
   e. Failsafe operation.
   f. Contacts shall be rated for 20 amps ballast load.
   g. Instantaneous operation
   h. Test switch.
   i. LED indicators for normal/emergency mode.
   j. Unit shall be capable to isolate catastrophic faults internally or external of unit.
   k. Unit shall be equipped with surge protection.

F. Photo Sensors (Daylight Harvesting):
1. Provide photo sensors (daylight harvesting) to be used as an input to the lighting control/dimming system.
2. Photocells shall be compatible with lighting control system to be used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Install lighting control devices as indicated on the Drawings.
2. Install all lighting control devices in accordance with Manufacturer's recommendations.
3.2 FIELD QUALITY CONTROL

A. Contractor Field Service:
   1. Provide qualified personnel to perform, schedule and coordinate: Terminate and label all wiring.

3.3 CLEANING

A. Clean all lighting control system devices at Substantial Completion.

3.4 ADJUSTING

A. Set time delay and sensitivity for all occupancy sensors in accordance with Manufacturer’s written instructions based on room type.

B. Adjust settings as required for all photo sensors (daylight harvesting) for system to function properly and to maximize system performance.

C. For each room/area with a ballast load transfer control relay device, simulate a power outage and test each device to ensure unit is functioning properly and appropriate loads are switched. Make adjustments as required.

END OF SECTION 26 09 23
SECTION 26 24 16 – 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. This Section includes the furnishing and installation of all distribution panelboards, and lighting and appliance branch-circuit panelboards.

B. Division of Work:
1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.
2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
   a. General Contractor:
      1) Install concrete pads:
         a) As specified herein.
         b) As directed by electrical Subcontractor.
   b. Electrical Subcontractor:
      1) Arrange and pay for all concrete pads.
      2) Coordinate pad location with General Contractor.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard.
   1. Include name of manufacturer and model numbers.
   2. Include materials, switching and overcurrent protective devices, SPDs, accessories and components indicated.
   3. Include dimensions and manufacturers’ technical data on features, performance, electrical characteristics, ratings and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Name of Manufacturer.
   2. Model number.
   3. Details of construction and installation.
   4. Project specific assembly drawings, including elevations, plans, sections, dimensions, weight, and conduit entry locations.
   5. Project specific electrical ratings:
      a. Voltage.
      b. Amperage.
      c. Short-circuit current rating of panelboards and overcurrent protective devices.
   6. Project specific enclosure types.
      a. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges and locks.
   7. Project specific color and finish.
   8. Project specific one line diagram.
   9. Project specific options and accessories.

C. Installation Instructions: For panelboards.
D. Operation and Maintenance Manuals: For panelboards.
   1. Equipment function, normal operating characteristics, and limiting conditions.
   2. Assembly, installation, alignment, adjustment, and checking instructions.
   3. Operating instructions for start-up, routine and normal operating, regulation and control, shutdown, and emergency conditions.
   5. Guide to “troubleshooting.”
   6. Parts list and predicted life of parts subject to wear.
   7. Project specific outline and cross sections, assembly drawings, engineering data, and wiring diagrams.
   8. Test data and performance curves.

1.4 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed submittals.

B. All panelboards and accessories shall bear the UL label.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer’s directions.

C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.

D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 240/120 V AC Maximum:
   1. Square D Company: NQ.
   4. Siemens Industry, Inc.: Type P1, P2 or P3 Series.

B. All panelboards shall be products of the same Manufacturer.

2.2 MATERIALS

A. General:
   1. All panelboards shall have [aluminum or ] plated copper bus bars and full-sized neutral bar.
   3. Bussing Type: Distributed phase.

B. Circuit Breaker Panelboards:
   1. Automatic circuit breaker type with individual breaker unit for each circuit, interchangeable, and removable without disturbing adjacent units.
   2. Complete front trim with door and flush lock, with 2 keys.
   3. Cabinets and fronts shall meet UL Standards for gutter space and material gage.
   4. All panelboards shall have common keying.
   5. All panelboards shall have a circuit directory frame with plastic cover and card mounted inside cover.
Panelboards

6. Trim for panelboards shall have door-in-door construction with piano hinge. Outer door shall permit full access to the panelboard interior. Inner door shall permit access to breaker operating handles and labeling but current carrying terminals and bus shall remain concealed.

7. Flush mounted double tub panelboards in finished areas shall have a common front cover.

8. Panelboard shall have electrical rating as indicated on the Drawings.

9. Flush mounted panelboards shall have cover flange to overlap cabinet.

10. Finish panelboards in gray enamel over rust inhibitor primer.

11. Branch circuit breakers are to be bolt-on type.

12. Load centers not allowed unless noted otherwise.

C. Short-Circuit Rating: Provide a single integrated rating of each panelboard certifying capability of withstanding fault stresses equal to the lowest interrupting rating of any overcurrent protective device contained in the panelboard.

D. Surge Protective Devices (SPD):
   1. Maximum UL 1449 (3rd Edition), Voltage Protection Rating (VPR):
      a. 208Y/120V and 120/240V Systems:
         1) L-N: 600V.
         2) L-G: 700V.
         3) N-G: 600V.
         4) L-L: 900V.
   2. The branch panel SPD shall be capable of surviving 6,000 ANSI/IEEE, Category C3 (10kA) impulses without failure or degradation of original performance characteristics of more than 10%.
   3. Maximum surge current rating shall be as indicated on the Drawings, based on ANSI/IEEE C62.41 standard 8x20ms current waveform.
   4. The SPD shall be connected to the panelboard bus bar through a dedicated 30 amp breaker provided by the equipment manufacturer.
   5. Warranty: Manufacturer shall provide a product warranty for a period of not less than 5 years from date of installation.

2.3 IDENTIFICATION

A. Panelboard Nameplate: Manufacturer’s name and trademark, voltage, amperage, number of phases, and number of poles shall be located at an accessible location 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: Computer-generated, typewritten circuit directory mounted inside panelboard door and placed in metal frame with transparent protective cover.
   1. Circuit directory shall identify specific purpose and location of equipment served with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the areas and conditions under which panelboards and enclosures are to be installed and notify Engineer in writing of conditions detrimental to the operation or the proper and timely completion of the work.

3.2 INSTALLATION

A. Anchoring:
   1. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secured.
   2. Locate top of enclosures approximately 6'-0" above floor, at a masonry joint if applicable.
   3. Mount free-standing distribution panelboards on 4-inch high concrete pads with 1-inch chamfered edges.
4. Where panelboards are flush mounted, stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab, not on grade, into accessible ceiling space below.

B. Circuit Directories: Upon completion of work, install project specific, computer generated, typewritten circuit directories in all lighting and appliance branch-circuit panelboards.

C. Panelboard Identification Nameplates: Label each panelboard with a nameplate complying with the requirements for identification specified in Division 26 Section “Identification for Electrical Systems.”

D. Device Nameplates: Label each branch circuit device in power panelboards with nameplate complying with requirements for identification specified in Division 26 Section “Identification for Electrical Systems.”

E. Install warning signs complying with requirements in Division 26 Section “Identification for Electrical Systems” identifying source of remote circuit.

3.3 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.

END OF SECTION 26 24 16
SECTION 26 27 26 – 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. This Section includes the furnishing and installation of all wiring devices and the major items listed below:
   1. Receptacles.
   2. Switches.
   3. Wall plates.
   4. Wall box dimmers.
   5. Box covers.

1.3 REFERENCES
   A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the
      following:
      1. NEMA - National Electrical Manufacturer's Association - Standards for general and specific purpose
         wiring devices WD-1, WD-5.

1.4 SUBMITTALS
   A. Shop Drawings: For wiring devices.
      1. Name of Manufacturer.
      2. Model number.
      3. Details of construction and installation.
      4. Electrical specifications and ratings.
      5. Dimensional data.
      6. Color and finish.

1.5 QUALITY ASSURANCE
   A. Regulatory Agencies Requirements:
      1. NEC - National Electrical Code (NFPA 70) as applicable to construction and installation of electrical
         wiring devices.
      2. UL Labels. Provide wiring devices which have been tested and are listed and labeled by Underwriters'
         Laboratories.

1.6 DELIVERY, STORAGE AND HANDLING
   A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
   B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign
      matter, damage by weather or elements, and in accordance with Manufacturer’s directions.
   C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above
      grade and enclose with durable, watertight wrapping.
   D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace
      rejected materials with new materials at no additional cost to Owner.
PART 2 - PRODUCTS

2.1 WIRING DEVICES

A. General:
1. Provide factory-fabricated wiring devices in type, color, and electrical rating as indicated on Drawings.
2. Where type and grade are not indicated, proper selection shall be determined by installer to fulfill the wiring requirements and to comply with NEC and NEMA standards for wiring devices.

B. Manufacturers:  Provide equal products by one of the following Manufacturers for switches and receptacles specified:
1. Arrow Hart - Cooper Wiring Devices
2. Leviton.
3. Hubbell, Inc.
4. Pass and Seymour - Legrand

C. Wall Plates:
1. Number:  Provide a single (switch or duplex outlet) wall plate for wiring devices grouped at each location.
2. Attachment:  Provide metal screws for securing plates to devices, screw heads colored to match finish of plate.
3. Construction:
   a. Stainless Steel:  0.04-inch thick, Type 302 satin finished stainless steel, brushed finish, accurately die cut, protected with release paper.
4. Plate Application:
   a. Flush Mounting Devices:  Beveled type with smooth edge:
      1) Finished Areas: Stainless steel, plastic. Coordinate with Architectural trades.
      2) Unfinished Areas: Galvanized steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Install wiring devices in accordance with:
   a. The Drawings.
   b. Manufacturer's written instructions.
   c. Applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation".
   d. Recognized industry practices to ensure that products serve intended function.
2. Delay installation of devices until wiring is completed.
3. Install receptacles and switches only in electrical boxes which are clean and free from excess building materials and debris.

B. Switches:
1. Install as indicated on the Drawings to control lights as indicated.
2. Where more than 1 wall switch is installed in same location, set under 1 cover plate.

C. Wall Box Dimmers:
1. Gang together multiple dimmer switches located at one location.
2. De-rate ganged dimmers in accordance with Manufacturer's instructions.
3. Do not operate on common neutral circuits.

D. Receptacles:
1. Locate approximately as indicated on the Drawings, long dimension vertical, with grounding pole at top.
2. Centerline generally at 18 inches above floor on a tile or block joint unless otherwise indicated on the Drawings. When mounting height exceeds 27 inches above floor, mount horizontally with grounding pole at left.
3. Refer to architectural Drawings for specific location requirements for architectural details when located above counters (long dimension horizontal), and for centering to meet architectural conditions.
4. Refer to mechanical Drawings for coordination with mechanical equipment, radiation, fin tube, grilles, and diffusers.
5. Provide bonding jumper from outlet to box.

E. Corrosion Resistant Receptacles: In areas designated as corrosive areas, install corrosion resistant receptacles, where indicated.

F. Wall Plates:
   1. Install cover plates on all wiring devices.
   2. Plate shall cover entire wall opening.

3.2 FIELD QUALITY CONTROL

A. Testing: Test wiring devices to ensure electrical continuity of grounding connections, and test after energizing circuitry, to demonstrate compliance with requirements.

3.3 PROTECTION OF WALL PLATES AND RECEPTACLES

A. Upon installation of wall plates and receptacles, advise Subcontractors regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

END OF SECTION 26 27 26
SECTION 26 28 00 – LOW VOLTAGE CIRCUIT PROTECTIVE 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. This Section includes the furnishing and installation of all low voltage circuit protective devices:
   1. The types of low voltage circuit protective devices required for the Project and specified in this Section include the following:
      a. Circuit breakers.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. UL 489 – Molded Case Circuit Breakers.
   2. NEMA AB1 – Molded Case Circuit Breakers.
   3. NEMA 250 – Enclosures for Electrical Equipment.

1.4 SUBMITTALS

A. Manufacturer’s literature for each type of low voltage circuit protective device furnished to include:
   1. Name of Manufacturer.
   2. Model.
   3. Time-current curves.
   4. Interrupt ratings.
   5. NEC class.
   6. Details of construction and installation.
   7. Options and accessories.

B. Installation Instructions: For low voltage circuit protective devices.

C. Operation and Maintenance Manuals: For low voltage circuit protective devices.
   1. Equipment function, normal operating characteristics, and limiting conditions.
   2. Assembly, installation, alignment, adjustment, and checking instructions.
   3. Operating instructions for start-up, routine and normal operating, regulation and control, and shutdown.
   5. Guide to “troubleshooting.”
   6. Parts list and predicted life of parts subject to wear.
   7. Project specific outline and cross sections, assembly drawings, engineering data, and wiring diagrams.
   8. Test data and performance curves.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed submittals.

B. Provide circuit breakers which have been tested, listed, and labeled by Underwriters’ Laboratory.
1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer’s directions.

C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.

D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 FUSES

A. General: Provide fuses manufactured by Bussmann, Inc. as required for all motor starters, fused disconnect switches, and other equipment requiring fuse protection as indicated on the Drawings, or in absence thereof, as selected by the installer to meet the specific electrical requirements of the equipment being served. Select only from the following:

1. Dual element fuse, 0-600 ampere, 250 or 600 volt, 200,000 ampere interrupting rating, Type R-K5: Buss “Fusetron”.

B. All fuses shall be by one Manufacturer.

2.2 CIRCUIT BREAKERS

A. General:

1. Provide required circuit breakers for installation in panelboards, switchboards, individual enclosures, or motor control centers. Circuit breaker Manufacturer shall be that of the equipment in which it is installed or shall be supplied by that equipment Manufacturer.

2. All breakers shall be rated for the applied voltage and have a minimum 10,000-amp interrupt rating.

B. Mechanism: Molded case circuit breakers shall have over center toggle-type mechanisms, providing quick-make, quick-break action. Breakers shall be calibrated for operation in an ambient temperature of 40 degrees C. Each circuit breaker shall have trip indication by handle position and shall be trip-free. 2 and 3 pole breakers shall be common trip.

C. Thermal Magnetic Trip:

1. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole.

2. Circuit breakers with frame sizes greater than 100 amperes shall have variable magnetic trip elements which are set by a single adjustment (to ensure uniform tripping characteristics in each pole).

3. Single pole 15 and 20 ampere breakers shall be SWD rated.

4. Manufacturer:
   a. Square D.
   b. General Electric.
   c. Cutler Hammer.

D. Enclosures:

1. Provide a UL listed circuit breaker enclosure for each individually mounted circuit breaker.

2. Enclosure to have NEMA rating for its intended location (NEMA 12, 3R, 4).

3. Provide handle mechanism padlockable in “OFF” position.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fuses in all combination motor starters, fused disconnects, and equipment as required. Install circuit breakers in all panelboards, switchboards, and motor control centers as required.

3.2 FIELD SETTINGS

Contractor shall perform field adjustments of protective devices as required to place the equipment in final operating condition.

END OF SECTION 26 28 00
SECTION 26 28 20 – ENCLOSED 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. This Section includes the furnishing and installation of all switching devices or means of disconnecting motors and other electrically powered equipment.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with NEMA - National Electrical Manufacturers Association: Standard KS1 for enclosed switches.

1.4 SUBMITTALS

A. Shop Drawings: For disconnect switches.
   1. Name of Manufacturer.
   2. Model number.
   3. Details of construction and installation.
   4. Assembly drawings, including elevations, plans, sections, dimensions, weight, and conduit entry locations.
   5. Electrical Ratings:
      a. Voltage.
      b. Amperage.
      c. Interrupt rating.
      d. Enclosure type.
   6. Color and finish.
   7. Options and accessories.

B. Installation Instructions: For disconnect switches.

C. Operation and Maintenance Manuals: For disconnect switches.
   1. Equipment function, normal operating characteristics, and limiting conditions.
   2. Assembly, installation, alignment, adjustment, and checking instructions.
   3. Operating instructions for start-up, routine and normal operating, regulation and control, shutdown, and emergency conditions.
   5. Guide to “troubleshooting.”
   6. Parts list and predicted life of parts subject to wear.
   7. Project specific outline and cross sections, assembly drawings, engineering data, and wiring diagrams.
   8. Test data and performance curves.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed submittals.
ENCLOSED SWITCHES

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in original, unbroken, brand marked containers, or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.

C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.

D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 FABRICATED SWITCHES

A. Manufacturers: Provide products produced by one of the following Manufacturers (for each type of switch):
   1. Square D Company.
   2. General Electric.

B. General:
   1. Provide heavy duty disconnect switches for all motors and equipment as indicated on the Drawings.
   2. Provide disconnect switches for all motors not in sight of supplying distribution panel whether indicated on the Drawings or not, as required by NEC.

C. Switch Enclosures: Provide disconnect switches with NEMA enclosures 1, 3R, 4X, 7, or 12 as indicated on the Drawings, or in absence thereof, as determined by installer to fulfill the requirements of the environment.

D. Heavy Duty Safety Switches:
   1. Provide heavy duty type, sheet steel enclosed safety switches, of the type and size and electrical characteristics indicated, surface mounted, fusible or nonfusible, rated at 250 volts, 60 hertz, 3 blades, incorporating quick-make, quick-break type switches, constructed so switch blades are visible in "off" position with door open; equipped with operating handle which is an integral part of the enclosure base and whose position is easily recognizable and is padlockable in the "off" position; with current carrying parts constructed of high-conductivity copper, and silver-tungsten type switch contact; with positive pressure type reinforced fuse clips.
   2. Fuse clips shall accept only Class R type fuses.
   3. All disconnect switches shall be horsepower rated.

E. Switch Interlock:
   1. Provide switches with dual cover interlock to prevent opening door with switch in "on" position or closing switch with door open.
   2. Interlocks shall be defeatable with the use of a screwdriver to intentionally gain access to an energized switch in the "on" position.
PART 3 - EXECUTION

3.1 INSPECTION

A. General:
   1. Examine the areas and conditions under which disconnect switches are to be installed and notify Engineer in writing of conditions detrimental to the proper and timely completion of the work.
   2. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 INSTALLATION

A. General: Install disconnect switches where indicated, in accordance with Manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve the intended function.

B. Coordination: Coordinate disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.

C. Location:
   1. Install disconnect switches used with motorized equipment within sight of the controller position unless otherwise indicated.
   2. Mount on wall whenever possible, otherwise provide supporting device adjacent to equipment being served.

D. Fuses: Provide fuses for disconnect switches in accordance with Division 26 Section "Low Voltage Circuit Protective Devices."

END OF SECTION 26 28 20
SECTION 26 50 00 – 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. This Section includes the furnishing and installation of all lighting and the major items listed below:
   1. Interior luminaires.
   2. Ballasts.
   3. Lamps installed in luminaires.
   4. Emergency lighting.
   5. Exit signs.
   6. Luminaire supporting systems.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
   1. ANSI-UL Standards:
      a. 924 - Emergency Lighting and Power Equipment.
      b. 935 – Fluorescent-Lamp Ballasts.
      c. 1598 – Luminaires.
   2. FCC Rules.

1.4 SUBMITTALS

A. Shop Drawings: For luminaries.
   1. Luminaire designation.
   2. Name of Manufacturer.
   3. Model number.
   4. Details of construction and installation.
   5. Dimensions and rough-in requirements.
   6. Voltage.
   7. Ballast Data:
      a. Name of Manufacturer.
      b. Model number.
      c. Operating characteristics
   8. Wiring diagrams.
   9. Color and finish.
   10. Options and accessories.

B. Sworn affidavit of luminaire conformance to State Fire Safety Board rules. Operation and Maintenance Manuals: For luminaires.
   1. Equipment function, normal operating characteristics, and limiting conditions.
   2. Assembly, installation, alignment, adjustment, and checking instructions.
   3. Operating instructions for start-up, routine and normal operating, regulation and control, shutdown, and emergency conditions.
   5. Guide to “troubleshooting.”
   6. Parts list and predicted life of parts subject to wear.
   7. Project specific outline and cross sections, assembly drawings, engineering data, and wiring diagrams.
   8. Test and performance curves.
C. Submit 2 copies of Record Drawings to Owner identifying maintenance and lamp replacement requirements.

1.5 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed submittals.

B. All equipment shall be UL listed.

1.6 WARRANTY

A. In accordance with the warranty provisions defined in the General Conditions and Supplementary Conditions:
   1. Includes all ballasts.
   2. Does not include lamps.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer’s directions.

C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.

D. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufacturers: Provide Manufacturer’s listed in the luminaire schedule.

B. General:
   1. Furnish and install all luminaires with lamps as indicated on the Drawings and as listed on the Luminaire Schedule.
   2. Furnish luminaires with all trims and accessories required for the various types of ceiling and wall construction.
   3. All ballasts used in fluorescent luminaires shall be Class "P" rated, high power factor, CBM certified and UL listed.
   4. All ballasts shall have an "A" sound rating, where available.
   5. Provide "damp" or "wet" location labels on all luminaires installed outdoors and in damp or wet interior locations.
   6. All recessed luminaires shall be thermally protected.
   7. Provide low temperature ballasts for all luminaires installed outdoors or in unheated interior spaces.
   8. All fluorescent troffers shall be painted after fabrication.
   9. All indoor luminaire diffusers shall conform with the Department of State Police, State Fire Safety Board, and School Fire Safety rules.

C. Exit Signs:
   1. Provide exit signs as indicated on the Luminaire Schedule.
   2. Include lamps with the exit signs.
   3. Exit signs shall have minimum of 6-inch high letters with directional arrows as indicated on the Drawings.

D. LED’s: Provide LED’s as provided from the manufacturer listed in the Luminaire Schedule.
PART 3 - EXECUTION

3.1 PREPARATION

A. Examine all pertinent details (architectural and otherwise) in the Contract Documents that are relevant to the installation of luminaires.

3.2 INSTALLATION

A. General:
   1. Install surface mounted, recessed, or semi-recessed luminaires to maintain the alignment, spacing, layout, and general arrangement indicated on the Drawings.
   2. Obtain approval of Engineer for all proposed changes that may be required due to field conditions and/or to avoid conflicts with Work by other trades.
   3. Install all luminaires in accordance with Manufacturer's recommendations.
   4. Equip all luminaires with the specified quantity of functional lamps prior to Substantial Completion.
   5. Install all wiring for emergency lighting and exit signs that are not local battery powered in a raceway system independent from other building wiring.

B. Coordination:
   1. Coordinate locations of recessed and surface mounted luminaires in ceiling systems with Division 09.
   2. Locate luminaires according to the reflected ceiling Drawings, if furnished.
   3. Coordinate location of luminaires in Mechanical HVAC and Plumbing areas with other trades.
   4. Notify Engineer of field conditions that contradict plans or specifications prior to beginning work.
   5. Coordinate space conditions that contradict or conflict with Work by other trades before installing luminaires.

C. Mounting and Support:
   1. Recessed LED Luminaires:
      a. Wire luminaires that are mounted in or on the underside of lay-in ceilings with flexible conduit to an outlet box on the rigid conduit system above, such that the rigid conduit system does not interfere with the removal of lay-in ceiling panels or luminaires.
      b. Do not support luminaires directly on ceiling panels.
      c. Install a minimum of four ceiling support system rods or wires for each luminaire. Locate rods or wires not more than 6-inches from the corners of each luminaire.
      d. Support Clips: Fasten to each luminaire and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
      e. Securely mount luminaires and electrical boxes to elements of the building structure such that luminaires will be square, plumb, and rigid; and will not fall or sag, and will not cause the suspended ceiling system to fall or sag.
      f. Install at least one independent support rod or wire from structure to a tab on each luminaire. Wire or rod shall have a breaking strength equal to the weight of luminaire plus a safety factor of 3.
      g. Provide all additional means (metal plates, etc.) necessary to support luminaires that would put excessive stress on the ceiling system.
   2. Surface Mounted Luminaires:
      a. Securely mount luminaires and electrical boxes to elements of the building structure such that luminaires will be square, plumb, and rigid; and will not fall or sag, and will not cause the ceiling system to fall or sag.
      b. Provide all additional means (metal plates, plywood backing, expansion bolts, toggle bolts, etc.) necessary to support luminaires that would put excessive stress on the ceiling system.

3.3 FIELD QUALITY CONTROL

A. Test all luminaires, lighting controls, and emergency lighting systems for proper operation.

B. All luminaires, exit signs, and emergency lighting systems shall operate properly.
C. Adjusting and Aiming:
   1. All final adjusting and aiming of luminaires (such as focusing all adjustable luminaires) shall be done
during the night hours. Contractor shall prearrange time with Engineer so Engineer and Owner can be
present. Final adjustments shall be made as directed in field by Engineer.
   2. Replace all defective LED’s and drivers immediately prior to Substantial Completion.

3.4 CLEANING

A. Clean all luminaire trims, exposed housings, doors, lenses, and reflectors immediately prior to Substantial
Completion.

END OF SECTION 26 50 00
SECTION 27 10 00 – COMMUNICATIONS OVERVIEW

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 furnishing and installation of all lighting and the major items listed below:
1. This section provides a project overview and general project and Contractor requirements.
2. The “Contractor” as referred to in these specifications, shall be the bidder whose bid is eventually chosen as the winner.
3. The “Engineer” as referred to in these specifications, shall be FTCH and its representative on this project.
4. The “Owner” as referred to in these specifications, shall be the Wayne State University and its representatives.
5. In the detailed specifications and on the contract drawings, the phrases “or equivalent,” “approved equivalent,” “approved equal,” “or equal” and “engineer approved equivalent” shall be used interchangeably and shall mean the same thing.
6. All equals, equivalents, or alternates shall be approved by the Engineer prior to ordering or installation. Without approval, deviation from the products listed in the specifications and on the drawings shall be presumed to be nonconforming and shall be removed and replaced at the direction of the Engineer and at the Contractor’s expense.

1.3 DESCRIPTION OF PROJECT

A. Cabling and Communications Infrastructure:
1. The communications portion of the project encompasses communications cabling and termination equipment and communications room racks and cabinets. The extent of the work shall be as shown on the drawing and detailed in these specifications.
2. Communications Cabling and Termination Equipment:
   a. All user UTP cabling shall be CAT-6E cable that is plenum rated.
   b. User cables shall be labeled according to the drawings and the specifications.
   c. All cables shall be terminated and tested as per the specifications.
   d. Provide two patch cords per data cable. Refer to drawings and specifications for size and color.
3. Provide complete build out of one communications room, including racks, wall fields and cable tray.
4. Contractor shall provide personnel and equipment for full training and commissioning of the system.
5. All cables shall be supported by approved supports.

1.4 STORAGE OF MATERIALS

A. All materials shall be secured when not in use by the Contractor.

B. It shall be the Contractor’s responsibility to secure all equipment including all material to be installed as part of the contract. No changes shall be made to the contract due to loss or theft of equipment and materials not officially accepted by the Owner.

1.5 SHOP DRAWINGS

A. Shop drawings shall be submitted for approval by the Contractor and approved by the Owner prior to final installation of the work. The shop drawings shall show all data relating to the structural, electrical, wiring diagrams, etc.
1.6 REFERENCE SPECIFICATIONS

A. All work applicable shall conform to the following standards:
1. ANSI/TIA/EIA-568-C.0 Generic Telecommunications Cabling for Customer Premises.
2. ANSI/TIA/EIA-568-C.1 Commercial Building Telecommunications Cabling Standard.
4. EIA/TIA-569-A: Commercial Building Standard for Telecommunications Pathways and Spaces including all Updates and Addenda.
5. EIA/TIA-570-A: Residential and Light Commercial Telecommunication Wiring Standard including all Updates and Addenda.
6. EIA/TIA-606-A: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings including all Updates and Addenda.
10. TIA/EIA-526-14-A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.

1.7 CONTRACTOR CABLING

A. The Contractor shall have a BICSI certified Registered Communications Distribution Designer (RCDD) identified that will be responsible for all aspects of the installation. (This person does not have to be a direct employee of the bidder but must inspect the work to ensure that it is done based on standards).
1. The resume of the RCDD, and a list of past projects the RCDD has worked on, shall be submitted with the bid response. The Engineer reserves the right to reject the RCDD, and require the Contractor to assign another if the RCDD is found not to have sufficient experience in projects of relatively the same scope.
2. If during the course of the work, the Contractor changes the RCDD assigned to the project, the Contractor shall provide the resume of the new RCDD and a list of projects of similar scope the new RCDD has worked on.

B. The Contractor shall show proof of an existing contractual relationship with the approved equipment manufacturer of the horizontal cabling system, and shall pass through the manufacturer's certification to purchaser.

C. All faceplates and termination hardware shall be sourced from the certifying manufacturer to assure quality control and validity of the manufacturer's warranty.

D. The Contractor shall accept complete responsibility for the installation, certification, and support of the cabling system. Contractor must show proof that he has the certifying manufacturer's support on all of these issues.

E. All work shall be performed and supervised by Telecommunications Technicians and Project Managers who are qualified to install voice, data, and image cabling systems, and to perform related tests as required by the manufacturer in accordance with the manufacturer's methods.

F. The Telecommunications Technicians employed shall be fully trained and qualified by the manufacturer on the installation and testing of the equipment to be installed. Evidence that the vendor is a current Certified Installer of the manufacturer must be provided in writing prior to work commencing on the structured cabling for the building.
G. The Contractor (including Subcontractor(s) if any) shall have a proven track record in cabling projects. This must be shown by the inclusion of details of at least 3 projects involving Category 6 or better cabling and optical fiber, which have been completed by the vendor in the last 2 years. Names, addresses, and phone numbers of references for the 3 projects shall be included. The installing contractor for each communication system shall have a minimum of 5 years of experience with the types of systems specified. A company employee must be certified to install, test and warranty; the product specified prior to a bid submittal. No exception to this will be allowed.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Contractor shall be familiar with the location(s) where the work will be done. No additional compensation will be made for items the Contractor claims he was not aware of during bidding.

B. Work Area:
   1. All work areas shall be cleaned at the end of each day. All debris shall be cleaned and removed from the site and disposed of in the approved container for the site.
   2. All equipment shall be moved out of common areas and stored in the Contractor's lay down area, or in other approved storage locations on Site.
   3. Any work that is low hanging, or may otherwise impede the general use of the space, and cannot be removed, shall be flagged and cordoned off by the Contractor.

C. All equipment and parts shall be installed in a neat and workmanlike manner. Good installation principles shall be used throughout the project.

D. All cables routed above the drop ceiling or in the ceiling area shall be installed square to the building. Diagonal cable runs are not permissible.

E. All cut edges of conduits, boxes, raceway, etc., shall be trimmed and filed so that no burrs or rough edges will damage cable as it is installed.

F. All surface raceways, including conduits in exposed areas shall be painted to match the existing colors of the surrounding area.

G. If in the course of the work, the Contractor damages, marks, or misplaces any ceiling tiles, the Contractor shall repair, and/or replace the ceiling tile to the original condition.
   1. The Engineer shall decide if ceiling tiles have been damaged. Based on the Contractors proposed fixes, the Engineer shall decide the best course of action to repair any damage done by the Contractor to the ceiling tiles.

H. It shall be the responsibility of the Contractor to repair any damage done to the structure or finishes in the building by the Contractor. The building shall be returned to its original condition prior to final sign off of the project.

3.2 DOCUMENTS

A. The Contractor shall fully read the contract documents including the detailed specifications, and the detailed drawings.

B. No additional compensation shall be made for any portion of the project which the Contractor did not know of or understand prior to providing the bid response.
C. In the case of any discrepancies between the detailed drawings and the detailed specifications, the Contractor shall provide the higher quality or more stringent requirement.

3.3 WORK PLAN-POST BID (CHosen CONTRACTOR ONLY)

A. Along with the submittals the Contractor shall provide a work plan for the implementation of the complete system. The plan shall include scheduled dates for major milestones, and all phases required for completion prior to final cutover.

B. The work plan shall list all items that must be completed by the Contractor or Owner to provide a smooth install of the system. The Contractor shall be responsible for all costs associated with the planning and cutover. The Owners only responsibility is to act as a liaison between the Contractor and the users.

C. The work plans shall include a time line and a cutover date for the systems. Contractor shall be responsible for all aspects of scheduling the work, including notification of the users, the administration, and any service provider.

D. The work shall commence within 10 days of award of the contract. The Contractor shall be responsible for attending weekly project meetings at the Owner's site to report on progress and keep the project team informed of the work being done.

E. The work plan will be reviewed at each weekly meeting for compliance and updates.

F. Work shall immediately begin on site surveys to determine the existing infrastructure and determining placement of new equipment. The Contractor shall be responsible for moving, relocating, and reconnecting any and all existing equipment required for the installation of the new systems.

G. After work plan and system approval by the Engineer the Contractor can begin work on infrastructure work that does not impede users.

H. The Contractor shall be responsible for working with the Owner’s Information Technology staff and administrators.
   1. Before commencement of work, the Contractor shall provide Installer Certificates as required by Division 01 Section “Submittal Procedures”, Paragraph 2.2 E.

END OF SECTION 27 10 00
SECTION 27 11 00 – COMMUNICATIONS ROOM

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 SECTION INCLUDES
   A. Parts and equipment required for a complete communications equipment room.

1.3 SYSTEM DESCRIPTION
   A. All equipment in the communications room shall be installed so that access is provided to all components, mechanical and electrical.
   B. All components of the communications room shall work together to form a cohesive and complete communications infrastructure.

1.4 COORDINATION
   A. Coordinate work under provisions in Division 1 of these specifications.
   B. Coordinate rack/cabinet work with the Electrical Contractor for placement of electrical connections.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Approved Equals for Racks and Cable Ladder Hardware:
      1. Hubbell.
      2. Homaco

2.2 MATERIALS
   A. Communications Rack: Existing to remain.
   B. Cable Ladder: Existing to remain.
   C. Patch Cord Organizers:
      1. Patch cords organizers shall be steel and shall allow routing of patch cables from electronics to the patch panels.
      2. Single rack unit organizer shall be Hubbell No. HC119ME3N with hinged cover, Hubbell No. HC119C. Refer to PCO-1 on detailed drawings.
      3. 2 rack unit organizer shall be Hubbell No. HC219ME3N with hinged cover. Refer to PCO-2 on detailed drawings.
      4. When multiple racks are provided in a row, the Contractor shall provide 1 Hubbell No. HC219MS1N per rack for use as an interbay organizer.
      5. Approved equals, Ortronics and Great Lakes Case and Cabinet.
D. Tie Wraps:
1. Tie wraps shall be used on the cable ladder of the rack systems to bundle the cables as they pass along the cable ladder. Cables shall be bundled in groups of no more than 24 cables.
2. Tie wraps should not be used above the drop ceiling or in cable tray except in limited circumstances. The pathway shall support the cables without the use of extra tie wraps.
3. Tie wraps shall never be used to support cables from building structure, electrical conduits, or lighting systems.
4. Panduit No. PLT2S-C or equal standard tie wrap. For use in general locations that are not plenum rated.
5. Panduit No. PLT2S-C702 or equal plenum rated tie wrap. Use only this type of tie wrap in plenum rated areas.
6. Panduit No. PLT2H-L00 or equal ultraviolet rated outside plant tie wrap. Use only this type of tie wrap for outside uses.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Location of the communications infrastructure shall be finalized in the communications room prior to installation.
B. Locate all equipment to be installed, and make certain that space is available for maintenance and service during the life of the system.
C. If any changes from the drawings are required, the Contractor shall submit a proposed layout of the communications room to the Engineer for approval prior to installation.

3.2 PREPARATION

A. Clean floor prior to installation of the communications racks.
B. Coordinate with all other Contractors and ensure that the locations of all cable tray and conduits are correct and will feed the rack system adequately.

3.3 INSTALLATION

A. Patch cord organizers shall be installed between all patch panels and electronics.
   1. Horizontal organizers shall be used for routing fiber and copper patch cords between patch panels and electronics.
   2. Refer to Rack layouts on detailed drawings for quantity of organizers to provide.
   3. Organizers shall be installed side by side where multiple racks are installed.
   4. If changes in the rack layout are required, contact the Engineer and get changes approved prior to installation.
B. Tie wraps shall be used sparingly in the overall installation.
   1. Tie wraps shall not be used in the cable tray or above the drop ceiling for support of cables. All cables shall utilize J-hooks, conduits, cable ladder, or cable tray for support in the ceiling area.
   2. Tie wraps can be used to group cables on the cable ladder of the rack systems. Group cables in bundles of no more than 24 cables.
   3. Trim all tie wraps so that the cut edge is smooth.

END OF SECTION 27 11 00
SECTION 27 16 00 – CAT-6 CABELLING

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 SECTION INCLUDES

A. This section includes parts and equipment required for installation, termination, and testing of user communications cables.

1.3 SYSTEM DESCRIPTION

A. The horizontal cabling consists of all systems from the user faceplate, to the patch panel in the communications room, and all connections in between.

B. Products and installation detailed in this section shall comply with all applicable requirements.

1. ISO 11801.
2. ANSI/TIA/EIA-568-C.0 Generic Telecommunications Cabling for Customer Premises.
5. ANSI/TIA/EIA-569-A Pathway and Spaces.
8. FCC 47 CFR 68.
9. NEMA – 250.
10. NEC – Articles 770 and 800.

1.4 COORDINATION

A. All cables shall be coordinated with the installation of the telecommunications raceways.

B. Coordinate all user cables with the furniture to be installed in the building. Make any adjustments prior to cable being installed.

C. Contractor shall walk the site during construction and shall verify all raceways are being installed as required to install the user data cables. Walk the site prior to drywall being installed or floors being installed when Floor boxes are being installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved vendors for copper station cables and connectivity are:

1. Belden DataTwist 600e.
3. CommScope Uniprise 7504 Cat6E.
4. Hubbell NEXTSPEED Cat 6 enhanced.
5. Superior-Essex/Ortronics NextGain Cat6EX.
2.2 MATERIALS

A. All UTP user/cabling installed shall be “Enhanced” CAT-6 rated or above.
   1. Category 6 cabling shall consist of 4 pairs of unshielded twisted pair, 23 AWG cables.
   2. Cables shall meet all requirement of TIA/EIA 568C.2 and all updates.
   3. All CAT-6 cables shall be installed in cable tray or supported by J-Hooks.
   4. Individual pair shall be marked in the standard 4 pair color code of blue/blue-white, orange/orange-white, green/green-white, and brown/brown-white.
   5. Each cable shall be marked sequentially with the footage of the cable. Each cable shall also be marked with the manufacturer of the cable and the type of cable installed or the cable part number.
   6. Cable and all connectors and patch panels shall meet or exceed the following electrical and physical requirements:

<table>
<thead>
<tr>
<th>DC RESISTANCE (max)</th>
<th>23 AWG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohms/100m @ 20°C</td>
<td>8.9</td>
</tr>
<tr>
<td>DC RESISTANCE UNBALANCED (max)</td>
<td></td>
</tr>
<tr>
<td>Individual Pair %</td>
<td>4.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHARACTERISTIC IMPEDANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (f)</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>1-500 Mhz</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DELAY SKEW (max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ns/100m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOMINAL VELOCITY OF PROPAGATION (NVP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Speed of light</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INPUT IMPEDANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (f)</td>
</tr>
<tr>
<td>1.0-100 Mhz</td>
</tr>
<tr>
<td>100-350 Mhz</td>
</tr>
<tr>
<td>350-500 Mhz</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FREQ.</th>
<th>ACR DB@100 m (min)</th>
<th>PS-ACR DB@100 m (min)</th>
<th>ELFEXT dB (min)</th>
<th>PS-ELFEXT m (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>772 kHz</td>
<td>74.2</td>
<td>72.2</td>
<td>70.0</td>
<td>72.3</td>
</tr>
<tr>
<td>1 kHz</td>
<td>72.2</td>
<td>70.2</td>
<td>67.8</td>
<td>72.3</td>
</tr>
<tr>
<td>4 kHz</td>
<td>61.5</td>
<td>59.5</td>
<td>55.8</td>
<td>52.8</td>
</tr>
<tr>
<td>10 kHz</td>
<td>53.3</td>
<td>51.3</td>
<td>47.8</td>
<td>44.8</td>
</tr>
<tr>
<td>16 kHz</td>
<td>49.0</td>
<td>47.0</td>
<td>43.7</td>
<td>40.7</td>
</tr>
<tr>
<td>20 MHz</td>
<td>46.3</td>
<td>44.3</td>
<td>41.8</td>
<td>38.8</td>
</tr>
<tr>
<td>31.25 MHz</td>
<td>41.2</td>
<td>39.2</td>
<td>37.9</td>
<td>36.8</td>
</tr>
<tr>
<td>62.5 MHz</td>
<td>32.0</td>
<td>30.0</td>
<td>31.9</td>
<td>28.9</td>
</tr>
<tr>
<td>100 MHz</td>
<td>24.5</td>
<td>22.5</td>
<td>27.8</td>
<td>24.8</td>
</tr>
<tr>
<td>200 MHz</td>
<td>11.0</td>
<td>9.0</td>
<td>21.8</td>
<td>18.8</td>
</tr>
<tr>
<td>250 MHz</td>
<td>5.5</td>
<td>3.5</td>
<td>19.8</td>
<td>16.8</td>
</tr>
<tr>
<td>350 MHz</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>400 MHz</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>500 MHz</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
7. All cables shall be Plenum Rated
8. After installation the CAT-6 cable shall be capable of transmitting the following signals:
   a. Voice.
   b. T-1.
   c. 10BASE-T (IEEE 802.3).
   d. 4/16 MBPS Token Ring (IEEE 802.5).
   e. 25/155 ATM.
   f. 100—VG-AnyLAN.
   g. 100 Mbps TP-PMD (ANSI X3T9.5).
   h. 100 BASE-T (IEEE 802.3).
   i. 1000 BASE-T (IEEE 802.3ab).
9. Ensure that cable passes all CAT-6 tests after installation.
10. CAT-6, 4 pair cabling shall be plenum rated unless specifically noted.
   a. Cat-6 UTP Cables for Data Communications shall be Green in color, Hubbell Cable # C6RPG or equal.
   b. Cat-6 UTP Cables for Voice Communications shall be Yellow in color, Hubbell Cable # C6RPY or equal.
   c. Cat-6 UTP Cables for Security Cameras shall be Purple in color, Hubbell Cable # C6RPP or equal.
   d. Cat-6 UTP Cables for Wireless Access Points shall be Green in color, Hubbell Cable # C6RPG or equal.
   e. Cat-6A STP Cables for Audio/Video shall be Blue in color, Hubbell Cable #C6AFTPSPB or equal.

B. Voice and Data modular jacks shall be CAT-6 rated, 8 position, unkeyed:
1. Each jack shall be an individually constructed unit and shall snap mount in an industry standard keystone opening (.760 inches x .580 inches).
2. Jack housings shall be high impact 94 V-0 rated thermoplastic.
4. Modular jack contacts shall accept a minimum of 1000 mating cycles with 5.0 miliohm (maximum) increase over initial with the use of an FCC compliant plug.
5. Modular jack contact wires shall be formed flat for increased surface contact with mated plugs.
6. Modular jack contacts shall be constructed of beryllium copper for maximum spring force and resilience.
7. Contact plating shall be a minimum of 50 micro inches of hard gold in the contact area over 50 micro inches of nickel.
8. Jack termination shall follow the industry standard 110 IDC.
9. Jacks shall have a designation indicating CAT-6.
10. Jacks shall utilize a paired punch down sequence. Cable pair twist shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.
11. Jacks shall terminate 22-26 AWG stranded or solid conductors.
12. Jacks shall terminate insulated conductors with outside diameters up to .050 inches.
13. Jacks shall be compatible with single conductor, 110 impact termination tools.
14. Jacks shall include translucent wire retention stuffer cap that holds terminated wires in place and allows the conductors to be visually inspected in the IDC housing.
15. Jacks shall be compatible with EIA/TIA 606A color code labeling.
16. Jacks shall accept snap on icons for identification or designation of applications.
17. Jacks shall be marked for T568A and T568B wiring schemes. TIA 568B wiring shall be used in all terminations throughout the communications system.
18. All CAT-6 modular jacks and panels shall meet or exceed the following transmission characteristics:
   a. Jacks shall be designed for 100 Ohm UTP cable termination.
   b. Jacks shall be UL verified for TIA/EIA Category 6 electrical performance.
   c. Jacks shall be UL listed 1863 and CSA certified.
   d. Jacks shall be manufactured by an ISO 9002 registered manufacturer.
19. CAT-6, 8-pin modular jacks shall be:
   a. Data Jacks shall be Hubbell # HXJ6OR or equal. Orange.
   b. Data Jacks for Voice shall be Hubbell # HXJ6W or equal. White.
   c. Data Jacks for Security Cameras shall be Hubbell # HXJ6OR -Orange.
   d. Data jacks for Wireless Access Points shall be Hubbell # HXJ6OR -Orange.
e. STP Shielded Data Jacks for Audio and Video connections shall be Hubbell # SJ6A2B.

C. Standard flush mount faceplates shall support all the jacks and connectors required.
   1. Faceplates shall be UL listed and CSA certified.
   2. Faceplates shall be constructed of high impact thermoplastic.
   3. Faceplates shall be 2-3/4 inches wide x 4-1/2 inches high (69.8 mm x 114.3 mm) for single gang, and 4-1/2 inches x 4-1/2 inches (114.3 x 114.3 mm) for double gang.
   4. Faceplates shall be available to mount 1, 2, 3, 4, or 6 jacks in a single gang and up to 12 jacks in a double gang configuration.
   5. Faceplates shall provide for TIA/EIA 606A compliant station labeling.
   6. Faceplates shall have plastic covers over the mounting screws that can be replaced with a clear plastic window over a printable paper insert.
   7. Each plate shall be fully configured with modular inserts. There shall be no open spaces in the faceplate.
   8. Match the color of the modular inserts to the color of the faceplate. All faceplates and inserts shall be office white unless otherwise noted.
   9. Single gang faceplate shall be Hubbell # IMF1OW.
  10. Double gang plate shall be Hubbell # IMF2OW.
   11. Double Gang, stainless steel, modular faceplates shall be Hubbell # IMS2
   12. Each single gang plate has 3 faceplate units (FPU’s) available to install inserts. Double gang plates have 2 sides, each with 3 FPU’s.
   13. Equip plates with the following parts as directed on the construction drawings.

<table>
<thead>
<tr>
<th>FPU</th>
<th>ITEM</th>
<th>PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Blank Jack</td>
<td>SFB10</td>
</tr>
<tr>
<td>.5</td>
<td>Blank</td>
<td>IMB05OW</td>
</tr>
<tr>
<td>1</td>
<td>Blank</td>
<td>IMB1OW</td>
</tr>
<tr>
<td>1.5</td>
<td>Blank</td>
<td>IMB16OW</td>
</tr>
<tr>
<td>1</td>
<td>1 Port Flat</td>
<td>IM1K1OW</td>
</tr>
<tr>
<td>1</td>
<td>2 Port Flat</td>
<td>IM2K1OW</td>
</tr>
<tr>
<td>1.5</td>
<td>1 Port Angled</td>
<td>IM1KA15OW</td>
</tr>
<tr>
<td>1.5</td>
<td>2 Port Angled</td>
<td>IM2KA15OW</td>
</tr>
<tr>
<td>1.5</td>
<td>SC Angled</td>
<td>IM1SCA15OW</td>
</tr>
<tr>
<td>2</td>
<td>Two SC Angled</td>
<td>IM2SCA2OW</td>
</tr>
</tbody>
</table>

D. Some locations will require custom stainless steel plates. These shall be configured with the correct connectors and pass thru’s to support all the data, audio and video.
   1. All shall be silk-screened to detail what each connector is for.
   2. Submit a product sheet for approval prior to purchase of the plates.

E. In addition to flush faceplates and surface housings, some installations call for integrated furniture outlets, GFI style outlets, and standard 106 style frames. These may be required at some surface raceway location. Field verify prior to ordering.
   1. The Contractors shall identify which type of outlet or frame is required at each location throughout the system.
   2. Match the particular outlet with the faceplate required.
   3. GFI, more commonly referred to as style line outlets, are rectangular and fit in a rectangular plate used for GFI receptacles.
   4. Each type of modular furniture has certain requirements for its voice and data modules. The Contractor shall coordinate with the furniture installer and provide the correct faceplate and outlets to match the color and style of the furniture.
   5. The 106 style frame fits in a common duplex electrical receptacle faceplate. The frame holds 2 or 4 modular jacks.
   6. For all connections that do not have a faceplate with a location for a laser printed paper label, the Contractor shall provide an engraved lamacoid label detailing the location number of each cable.
   7. GFI Plates shall be Hubbell # ISF2OW, ISF3OW, ISF4OW or ISF6OW; or equal.
   8. 106 style plates shall be: Hubbell # BR106C or Q106) or equal.
9. Style Line plates shall be:
   a. Two-port, Hubbell #ISF2OW.
   b. Three Port, Hubbell #ISF3GY.
   c. Four Port, Hubbell #ISF4W.

F. Provide surface mount boxes for termination of cables as shown on the drawings.
   1. Install a surface mount box at location for termination of the CAT-6 jack.
   2. Single cable surface box shall be Hubbell #ISM1OW.
   3. Multiple cable surface box shall be Hubbell #ISM40W.

G. All cables shall be supported in the ceiling a minimum of every 5 feet. Support can be provided by installing cable inside cable tray or conduit, or by installing J-hooks every 5 feet.
   1. J-hooks shall provide a smooth steel support for cables as they route through the ceiling.
   2. Each hook shall have a galvanized finish.
   3. Steel, UL listed, ultimate static load limit 50 pounds rated to support Category 3 and higher cables, and optical fiber cables.
   4. If required, assemble to manufacturer recommended specialty fasteners, including beam clips and flange clips.
   5. Acceptable products shall be by CADDY, and shall be the CableCat series of J-hooks.
   6. Provide surface mount boxes for termination of cables as shown on the drawings.
   7. Single cable surface box shall be Hubbell #ISM1OW.
   8. Multiple cable surface box shall be Hubbell #ISM40W.

H. Firestopping shall be completed inside and around all conduits after cable installation. Firestop for the area between the cable and the edge of the conduit shall be Nelson No. FSP, CLK or LBS+. Contractor shall install the best firestop for each individual installation.
   1. Firestop shall be installed with regard to local and national building codes.
   2. The firestop shall be a putty like substance that expands under heat and will not allow flame to pass for a designated period of time.
   3. Firestop shall conform to all NEC, NFPA, and UL requirements.
   4. Some wall pass-thru’s are shown on the drawings. The Contractor shall utilize these where possible.
   5. Where the contractor must install cables through a wall where there is no pass-thru already provided, the Contractor shall be responsible for installing a fire-rated pass-thru and fire-stopping the conduit after cable installation.

I. CAT-6 patch panels for mounting in a 19-inch rack shall be Hubbell No. UDX48E or approved equal CommScope, Ortronics, Leviton, or Beldon. See Transmission characteristics above for requirements.
   1. Panels shall be made of black anodized aluminum, in 48 port configurations.
   2. Panels shall be manufactured with a rolled edge at the top and bottom for stiffness.
   3. Panels shall have modular jacks employing staggered array contacts with a flat “hairpin” design made of beryllium copper with a minimum 50 micro inch gold plating on contact surfaces over 50-100 micro inch of nickel compliant with FCC Part 68.
   4. Panels shall have rear cable support bar for strain relief which shall clip to the rear of the patch panel.
   5. Panels shall be marked for the panel, communications room and rack with a large laser-printed label.
   6. Panels shall provide wiring identification and color code and maintain a paired punch down sequence that does not require the overlapping of cable pairs.

J. Shielded patch panels for connection of certain cables as noted on the drawings shall be steel and allow multiple modular jacks to be installed in the jacks.
   1. 24 port blank panels shall be Hubbell #PSJ24S or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all pathways prior to installation of all cables.
B. Identify locations of all user conduits and backboxes prior to cable installation.

C. The Engineer or the Owner has the right to make adjustments to the location of any outlet to a new location within 7 wall-feet of the original location. If the change is made prior to final cable termination, and prior to any raceway being installed, then the changes shall be a no cost change to the contract.

D. Identify all locations where cable will route through furniture raceway or other nonstandard conduit or raceway installation. Make arrangements to install and terminate all cables in accordance with TIA/EIA 568 standards.

3.2 PREPARATION

A. Locate main path for all cables and install J-hooks where cable tray is not provided.

B. Coordinate with other trades to install a clear, straight path down major corridors for the routing of user cables back to the communications closet.

C. Plan installation of cables along cable ladder of rack system in communications room. All cable shall be neatly routed in groups of no more than 24 cables.

3.3 INSTALLATION

A. CAT-6 cabling shall be installed according to TIA/EIA 568-B standards, including all updates and addenda.
   1. When installing CAT-6 cables, care shall be taken to avoid crimping or bending the cable past the manufacturer’s recommended bend radius.
   2. During installation, the cables shall not be pulled across the ceiling tiles or the structure of the building. This may cause damage to the cable jacket.
   3. Adhere to all pulling tensions and bend radii during installation. Excessive pulling or bending can cause the cable to fail tests after installation. Any cable that does not pass the CAT-6 tests after installation shall be fixed or replaced at the Contractor’s expense.
   4. All cables shall route neatly in the ceiling. Whether they route in cable tray or J-hooks, the cables shall be neat and orderly.
   5. There shall be no more than 50 cables in each J-hook. Provide additional J-hooks as required.
   6. Support all cables at a minimum of every 5 feet.
   7. Provide a short coil of extra cable where the cable enters the vertical conduit. The coil shall consist of no less than 1-1/2 feet.
   8. Provide enough slack in the backbox to fully remove the faceplate and jack and allow work to be done on the cable.
   9. When installing cables in the communications room, all cable shall route neatly through the cable tray and cable ladder.
  10. When transitioning from the ceiling area to the cable ladder of the rack system, all cable shall route through conduits or be attached to vertical section of cable ladder. The Contractor shall provide the conduits shown and any additional conduits or cable ladder required to neatly transition cables from the ceiling to the rack.
  11. Bundle cables in groups of no more than 24 cables as it routes along the cable ladder.
  12. Cables shall route down each side of a rack for termination. Split each panel into 2 sides. The first 12 positions on a panel are on the left, and positions 13 through 24 are on the right. Route the cables for panel positions 1 through 12 down the left cable ladder and route the cables for positions 13 through 24 down the right cable ladder.
  13. Each patch panel shall utilize a rear organizer for holding the cables as they route to the punchdown field.
  14. Cables shall be bundled in groups of 4 as they route through the rear cable organizer.
  15. When terminating cables, ensure that the smallest amount of jacket is removed from the final termination point of the cables.
  16. Pair twists shall be maintained up to the IDC jack for all the cables.
  17. When terminating cables on the back of patch panels, or on modular jacks, use only single point, 110 style punchdown tools. Multiple pair punchdown tools are not permitted for terminating individual 4 pair cables.
19. Provide a service loop of the cables on the vertical cable ladder. The loop shall extend no less than 1 foot below the termination point on the patch panel. Route the cables 1 foot below the patch panel, and then back up to the panel. This will provide room for future moves and additions to the rack.

20. Each cable shall have a self adhesive, self laminating, laser printed label at each end. The label shall show the location identifier of that cable. Labels shall be installed no more than 4 inches from the termination point of the cable.

B. CAT-6 data/voice jacks shall be installed at the user end of each CAT-6 cable installed in the system.
   1. Jacks shall be installed to provide minimal signal impairment by preserving wire pair twists as close as possible to the point of mechanical termination.
   2. Jacks shall be installed according to manufacturer’s instructions and properly mounted in plates, frames, housings, or other appropriate mounting devices.
   3. Jacks shall be installed such that cables terminated to the jacks maintain minimum bend radius of at least 4 times the cable diameter into the workstation outlet. Cables shall be terminated on jacks such that there is no tension on the conductors in the termination contacts.
   4. All voice/data jacks shall be office white unless noted otherwise.

C. Faceplates shall be mounted straight and level with the floor and walls of the building.
   1. Jacks and/or connectors shall be terminated to the appropriate cable and inserted in the correct orientation into the faceplate prior to the mounting of the faceplate.
   2. Jacks shall be inserted into the faceplate left to right, then top to bottom. 2 gang plates shall be labeled left to right, then top to bottom for each gang.
   3. Cable slack shall be stored behind the faceplate in such a way that allows the minimum bend radius of the cables to be maintained as per the following:
      4. Fiber Optic Cable, a minimum of 2 feet (1 m) slack, with a minimum bend radius of 1.18 inches (30 mm). UTP cable, a minimum of 1 foot of slack, with a minimum bend radius of 4 times the cable diameter.
   5. Care shall be taken when mounting the faceplate to avoid crimping or kinking the cables.
   6. Faceplates shall be securely mounted to a surface mounted housing, a recessed box, or box eliminator bracket.
   7. Each faceplate shall be labeled with laser printed paper inserted behind the clear plastic label strips.
   8. The label shall show the location identifier of the faceplate and the letter designation for each cable. The label shall be as large a font as possible and easily readable.
   9. Each faceplate comes with a label strip at the top and the bottom.

D. Surface Mount boxes
   1. Jacks and/or connectors shall be terminated to the appropriate cable and inserted in the correct orientation into the surface mount box.
   2. When the surface mount jack is mounted above the ceiling the cable shall be coiled and the cable and surface mount box shall be kept off of the ceiling grid
   3. Attach the coil to the building structure with a plenum rated tie-wrap.
   4. Label each surface mount box for the cable number. Also install a wrap-around label on each cable.
   5. When attaching a surface mount box to a piece of furniture or to a power pole the contractor shall drill a hole in the furniture/pole that is larger than the hole on the back of the surface box.
   6. Screw the surface box to the furniture or to the pole. Adhesive only solutions are not adequate.

E. Proper support of cables is of paramount importance when installing a cable infrastructure. All cables not in conduit or cable tray shall be supported via J-hooks a minimum of every 5 feet.
   1. Routes of cables shall be parallel or perpendicular to the walls of the building.
   2. Install the J-hooks to minimize changes in the level of the cables as they route through the J-hooks.
   3. Do not install more than 50 cables in any 1 J-hook. Provide additional hooks where more than 50 cables route along a main route.
   4. All communications shall route as high in the ceiling as possible while still being accessible and staying away from other utilities.
   5. When installing the cable through the J-hooks, they shall all have relatively the same droop between hooks. All cables shall be installed neatly and squarely.
   6. Secure the J-hooks to the building structure with beam clamps and threaded rod as required to support the cables.
7. J-hooks shall never be attached to drop ceiling support wires. Cables shall never be supported by drop ceiling wires.

F. Firestopping is required at all riser conduits and all pass thru’s.
   1. Each cable tray penetration of a wall shall be firestopped after cable installation. Use pillow type firestop to allow additional cables to be installed in the future.
   2. Where riser conduits pass through floors, the area between the concrete and the conduit shall be firestopped. This shall be completed with a putty or liquid firestop product. Fill in the space with mineral wool, and then install the firestop on top. All firestop shall be of sufficient thickness to secure the rating required by code.
   3. After final cable installation, install a putty firestop around all cables where they enter and exit conduit pass thru’s and conduit risers.
   4. All firestop shall be installed to provide the fire rating as described by local fire code.
   5. It shall be the responsibility of the Contractor to verify that all conduits, walls, and raceways required to be firestopped have been firestopped.

G. CAT-6 patch panels shall be installed between patch cord organizers in the racks.
   1. Panels shall be installed to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination to the patch panel shall be no greater than a 1/2 inch (13 mm).
   2. Panels shall be installed according to manufacturer’s instructions and properly mounted to a rack, cabinet, bracket, or other appropriate mounting device.
   3. Panels shall be installed such that cables terminated to the panel can maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts. Cables shall be terminated on the panels such that there is no tension on the conductors in the termination contacts.
   4. Each patch panel shall have 2 rear cable organizers for routing cable from the vertical cable ladder to the patch panel. 1 organizer for each row of 24 cables.
   5. The label for each outlet on the panel shall be the same as the wraparound label on each end of the cable.
   6. Each label shall line up directly below or above the outlet on the panel. Misaligned labels will not be permitted.

H. Shelves shall be installed where equipment will need to be supported and the equipment is not directly rack mountable.
   1. Contractor shall supply shelves that correspond with the weight of the equipment being supported by the shelf.
   2. Shelf shall be able to support 50 pounds or more.
   3. Blank panels shall be provided for locations where equipment or panels must be mounted flat on the rack, but are not directly rack mountable. See drawings for details.

END OF SECTION 27 16 00
SECTION 27 72 00 – SUBMITTALS

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 SECTION INCLUDES

A. This section provides the Contractor with requirements in regard to Product Data, Shop Drawings and Product Samples collectively referred to as “Submittals”.

B. The requirements of this section deal only with those submittals that are required to be provided by the chosen contractor prior to beginning the work. No submittals in this section are required to be provided with the Bid Response.

C. The requirements contained herein should be considered bound and apply to all specification sections per this contract.

1.3 SUBMITTALS

A. The contractor shall provide material submittals to the Construction Manager or directly to the engineer, whichever is managing the project.

B. Prior to beginning work, the chosen Contractor shall provide 4 sets of material submittals. All paper submittals shall be bound in a 3-ring binder. The binder shall be clearly marked with the project name and number, and additionally marked as “submittals.”

C. Send an Excel spreadsheet in .xls format to the designer for their use in reviewing the submittals.

D. PDF documents for submittals are allowed.

PART 2 - PRODUCTS

2.1 PRODUCT DATA SHEETS

A. Product data sheets shall consist of the manufacturers detailed specification sheets or “cut- sheets” for each product that is to be installed by the contractor or any subcontractors.

B. Product data sheets shall minimally include, but shall not be limited to:
   1. Part Number.
   2. Manufacturer.
   3. Description of the product.
   4. Physical dimensions and characteristics of the product.
   5. Picture or manufacturers drawing of the item, where applicable.
   6. Electrical characteristics of the product including heat-load for active electronics.
   7. Optical characteristics of the product for Fiber-Optic equipment and cable.

C. Provide product data sheets for all equipment and cabling that is to be installed by the contractor.
2.2 SHOP DRAWINGS

A. Shop Drawings shall consist of detailed drawings showing actual connectivity and cable types for the systems noted below:
   1. Data Network.
   2. DSL.

B. Shop drawings shall also be provided for systems that the contractor intends to connect differently than what is shown on the contract drawings or where no connectivity is shown.

2.3 PRODUCT SAMPLES

A. Product Samples shall consist of a sample of the actual product that is to be installed.

B. Samples shall be tagged with the part number and specification section to which it pertains.

C. Product Samples shall be provided for the following: None at this time.

PART 3 - EXECUTION

3.1 DOCUMENTS

A. The Contractor shall provide all submittals to the Construction Manager or the Engineer and obtain owner's approval prior to beginning installation.

B. The Contractor shall provide 4 sets of Product Data Sheets.
   1. All Product Data sheets shall be bound in a 3-ring binder. The binder shall be clearly marked with the project name and number, and additionally marked as “Product Data Sheets.”
   2. The data sheets in the binder shall be segmented to match the specification section and page number they pertain.
   3. The Contractor shall highlight the actual part number on the sheet of the component that they are submitting. If no part number is highlighted or marked with an arrow, then the entire submittal package will be rejected and sent back for re-submission.
   4. Contractor shall submit a spreadsheet with their data sheets that details the manufacturer, part number and common name of the products that they are submitting.

C. The Contractor shall provide 4 sets of Shop Drawings.
   1. Shop drawings shall be marked for the specification section of the bid documents to which they pertain.
   2. All shop drawings that are required to be drawn on the building background shall be provided on full-size drawings the same scale as those in the bid documents.
   3. All lines on the shop drawings shall be highlighted or completed in ink that is not the same color as that provided in the bid documents.
   4. The contractor shall provide a drawing legend detailing all symbols used in creation of the shop drawings.

D. The Contractor shall provide one of each product sample required to be submitted.
   1. Provide a cutsheet with each product sample detailing the specifics of the product and what it is proposed to be used for.

3.2 SUBMITTAL REQUIREMENTS

A. Submittals shall be provided for approval prior to installation of the work.

B. Any equipment installed that does not have an approved submittal associated with it can and will be removed from the project and replaced with other equipment as defined by the Engineer. All replacement costs shall be the responsibility of the Contractor.
C. It shall be the responsibility of the Contractor to provide the submittals for review in sufficient time so as to not delay the installation. Work with the Construction manager on the schedule.

END OF SECTION 27 72 00
SECTION 27 76 00 – LABELING

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 SECTION INCLUDES

A. This section provides direction on labeling of cables and devices.

PART 2 - PRODUCTS

2.1 LABELING PRODUCTS INTERIOR

A. Laser printed, self-adhesive wrap around labels for CAT-6, Coax and audio/video cabling user cables shall be Brady LAT-18-361 or equivalent.
   1. Label shall be 1.00 inch width x 1.33 inch high.
   2. Labels shall come on a sheet with 7 labels per row with a white and transparent matte finish.
   3. Sheet size shall be 8-1/2 inch x 11 inch.
   4. Printable area shall be a minimum of 1.00 inch width x 0.50 inch high.
   5. All labels shall be printed through a laser printer using labeling software.
   6. The Contractor shall submit a proposal for the labeling scheme for all audio and video wiring. The Engineer shall approve of the scheme prior to all labeling.

B. Laser printed, self-adhesive wrap around labels for fiber cables shall be Brady LAT-19-361 or equivalent.
   1. Label shall be 1.00 inch wide x 3.167 inch high.
   2. Labels shall come on a sheet with 7 labels per row with a white and transparent matte finish.
   3. Sheet size shall be 8-1/2 inch x 11 inch.
   4. Printable area shall be 1.00 inch wide x 0.97 inch high.
   5. All labels shall be printed through a laser printer using labeling software.

C. Interior exposed fiber cable and fiber cable inside inner duct shall be labeled every 100 feet, label shall be Panduit No. PST-FO.
   1. Label shall be covered with a clear laminate to protect the legend of the label.
   2. Attachments for tie wraps shall be available on the label to attach it to the cable or inner duct.

D. Laser printed, paper labels shall be used to label user faceplates and patch panels.
   1. Individual paper labels shall be installed behind the clear plastic strips of all user faceplates and surface mount housings.
   2. The labels shall show the location identifier number and letter of each individual cable. See Specification Section 17160 for details.
   3. Paper insert with laser printed identifiers shall be provided for each outlet on a patch panel.
   4. Patch panel labels shall be printed in a strip and inserted into plastic designation strips that are 17 inches long. Designation strips shall be self-adhesive, 3/8 inch high and shall be Hol-Dex from Aigner Index.
   5. Paper inserts shall fit inside the designation strips.

E. Engraved, lamacoid labels shall be supplied for locations where paper inserts are not available.
   1. All engraved labels shall be self-adhesive for attachment to various products.
   2. Engraved labels shall be installed at locations including but not limited to:
      a. Racks and cabinets.
      b. User cable locations where paper inserts are not available.
      c. Ground bars.
   3. Size the phenolic labels for their individual uses. Provide a sample to the Engineer for approval prior to ordering or installation.
PART 3 - EXECUTION

3.1 PREPARATION

A. Terminate all cables in proper color code sequence.
B. Clean any surfaces where an adhesive label is to be installed.
C. Prior to beginning the work, the contractor shall submit to the engineer a plan for labeling all the cables. This shall take into account to what components each cable is connected.

3.2 EXECUTION

A. Cable labels for CAT-6 user cables from the faceplate to the patch panel shall be installed within 4 inches of the end of the cable sheath.
   1. The location identifier is made up of 3 fields, and a sample might look like this:
      
      A-X-YY

      Label is shown for reference only, Refer to drawing for labeling scheme.
      
      This system of identification provides the Owner with an easy way to keep track of cables, and where they are located or terminated.
   2. The cable label shall be similar to the label below:

      | A-X-YY |
      | A-X-YY |
      | A-X-YY |

   3. Provide a sample label to the Engineer for approval prior to installation of all labels.
   4. Labels shall be installed at each end of each cable. Shall be within 4” of the termination.

B. Fiber Panel labeling shall be done for the front of each fiber optic patch panel.
   1. The figure below demonstrates the layout of the fiber panel label. Each label shall be customized for each individual panel. The figure below is for the 72 port panel.
   2. Contact the Engineer with questions on the correct labeling prior to installation.

<table>
<thead>
<tr>
<th>12 SM TO HIGH SCHOOL</th>
<th>12 MM TO COMM RM “B”</th>
<th>12 SM TO COMM RM “C”</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 03 05 07 09 11</td>
<td>01 03 05 07 09 11</td>
<td>01 03 05 07 09 11</td>
</tr>
<tr>
<td>02 04 06 08 10 12</td>
<td>02 04 06 08 10 12</td>
<td>02 04 06 08 10 12</td>
</tr>
</tbody>
</table>

Figure A – Label for 36 Port Fiber Patch Panel

C. Paper inserts shall be supplied for all faceplates and patch panels labels.
   1. Paper inserts for the faceplate shall detail the exact location identifier for each cable.
   2. They shall fully cover the background of the insert space on the faceplate, but all numbers and letters of the identifier shall be visible after installation of the plastic cover plate.
3. The paper insert for a standard faceplate will look like this:

Top Label Strip

Bottom Label Strip

4. Provide a sample label to the Engineer for approval prior to installation of all labels.

D. Camera cable shall be labeled.
1. For CAT-6 cables the contractor shall label as detailed on the drawing
2. Each cable shall have a unique identifier and shall be labeled with a wraparound label at each end with an adhesive, self-laminating label showing that unique identifier.
3. Cable labels for camera cables shall be installed within 4 inches of the end of the cable sheath.

A-X-YY-DDD

Label is shown for reference only, Refer to drawing for labeling scheme.

a. The cable label shall be similar to the label below:

<table>
<thead>
<tr>
<th>A-X-YY-DDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-X-YY-DDD</td>
</tr>
<tr>
<td>A-X-YY-DDD</td>
</tr>
</tbody>
</table>

b. Provide a sample label to the Engineer for approval prior to installation of all labels.

A = Communications room
BB = Patch panel where cable terminates
CC = Port on patch panel where cable terminates
DDD = Camera number

E. All labels shall be installed to more easily identify the cables and ports on all panels. If there are any questions regarding labeling, contact the Engineer prior to installation.

F. Engraved lamacoid labels shall be provided and installed whenever there is no location for paper inserts on faceplates, power poles, poke thru’s, floor boxes, modular furniture and surface raceway.
1. Engraved lamacoid labels shall provide the same labeling as the paper inserts, but they shall be self-adhesive.
2. These labels shall be adhered to the location closest to the modular jack.
3. Individual letters shall be provided for each cable. An overall location identifier can be provided for all the cables at that faceplate or floor box.
4. Engraved labels for rack shall be at least 1-1/2 inch high with letters 1 inch high.
5. These labels shall be affixed to the top and front of each rack or cabinet. Verify that the label will fit the rack or cabinet prior to purchasing.

G. All labels shall be installed to more easily identify the cables and ports on all panels. If there are any questions regarding labeling, contact the Engineer prior to installation.

END OF SECTION 27 76 00
SECTION 27 77 00 – TESTING

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 WORK INCLUDED

A. This section provides direction on testing of copper cable, labeling, and administration of the drawings and information.

1.3 SYSTEM DESCRIPTION

A. All cables installed shall be tested and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved vendors for cable testers are: Fluke; or equal.

2.2 TESTING PRODUCTS

A. Category 6 cable shall be tested.
   1. Cable tester shall support Cat 6 channel and permanent link certification.
   2. Tester shall provide accuracy beyond TIA level III requirements traceable to laboratory reference standards.
   3. Through add on fiber optic probes, the tester shall be able to test multimode and single mode fiber cable.
   4. Test results shall be able to be stored on internal or removable compact flash memory cards.
   5. Tester shall have optional talk set for discussions over the cable being tested.
   6. Tester shall support a frequency range of 1-500 MHz with accuracy to the current proposed TIA Level III.
   7. Tester shall support the following tests:
      a. Near end crosstalk (NEXT).
      b. Attenuation.
      c. Equal level far end crosstalk (ELFEXT).
      d. Return loss.
      e. Ambient noise.
      f. Wire map shall identify miswires, shorts, opens, reversals, and split pairs.
      g. Shall measure cable length and distance to faults (if any).
      h. Propagation delay.
      i. Loop resistance.
   8. Tester shall support the following test standards:
      a. TIA Cat 6 and ISO Class E.
      b. TIA Cat 5.
      c. TIA TSB-95.
      d. TIA Cat 3, 4 and 5 per TIA TSB-67.
      e. UTP, STP, SCTP coaxial and twinax cabling.
      f. IEEE: all Ethernet 802.3UTP and fiber PMD interfaces including 10GBASE-T; other 802.x PMD interfaces including token ring and demand priority.
      g. ATM: All UTP and fiber PMD interfaces.
   9. Tester shall have all required probes and accessories required to perform CAT-6 tests and “Network Tests.”
   10. Tester shall have been recently calibrated (within 4 months), and shall be utilizing the latest software.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Testing shall be completed after fiber is installed inside the fiber patch panel and the fiber panel has been put together.

B. All cables and panels where cables terminate shall be labeled with the cable label or name of each individual cable. Identify how each cable and panel will be labeled.

3.2 PREPARATION

A. Terminate all cables in proper color code sequence

B. Clean any surfaces where an adhesive label is to be installed.

3.3 CAT-6 TESTING

A. Cable tests for CAT 6 cables shall be provided for each user CAT-6 cable.
   1. Prior to beginning the testing, the Contractor shall provide the Engineer with a notice that testing will begin. Written notice shall be given at least 3 business days prior to testing beginning.
   2. Tester shall be calibrated each day with manufacturer provided calibration cable.
   3. Tests shall be saved under each cables unique location identifier.
   4. Contractor shall provide the correct cables and probes specifically for the cable and modular jacks that are being tested.
   5. During the test the tester shall be set to check all “Network Tests.”
   6. Test results shall be provided in hard copy and soft copy. Along with the soft copy, provide a copy of the software required to read the test results.
   7. Contractor shall supply 2 copies of the paper results and 2 copies of the file results.
   8. Provide all paper results in 3-ring binders. Binders shall have a cover that shows the job name, job number, building and closet where the cables were tested, and the range in the location identifiers of the cables tests provided.
   9. Tester shall be set to match the cable being tested.
   10. Contractor is responsible for ensuring that all cables pass the tests. Any cable found not to pass shall be removed and replaced at the Contractor’s expense.

END OF SECTION 27 77 00
SECTION 27 77 50 – TRAINING

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 SECTION INCLUDES

A. This section includes directions for the Contractor regarding system cutover and training.

1.3 SYSTEM DESCRIPTION

A. The Contractor shall provide training on all the installed systems.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 GENERAL TRAINING REQUIREMENTS

A. The Contractor shall provide training on all systems installed or upgraded as part of the contract.
   1. The Contractor shall involve the personnel from the Owner’s office in the implementation and configuration of the network systems.
   2. Prior to the cutover of the system, the Contractor shall work with the Owner on the training that will be provided. The Owner and the Contractor shall schedule the training at a time beneficial to both.
   3. Each system is to have training provided as part of the installation.
   4. Each training session shall include.
      a. This training will give an overview of the capabilities of each system, and the methods to be employed in utilizing the system.
      b. The Contractor shall provide a syllabus detailing what will be discussed at the training, and notes for the Owner to refer to during the life of the system. The notes shall list directions for general use of the system and possible fixes to general issues that could occur.
      c. Training shall include as-built diagrams of the connectivity, a walk-thru of the system, a demonstration of actual user interface with the system, and directions on its general use.
      d. This training is only meant to give an overview of each system. In depth training shall be provided for an in-depth analysis of certain systems as described below.
   5. For all training, the Contractor shall pay all expenses.

B. Create cheat sheets for all systems that the users can keep after the training.
   1. Cheat sheet shall include details on how to use the system.
   2. A copy of the cheat sheet shall be laminated and installed at the system location.
   3. For individual training the contractor shall provide a cheat sheet for each person being trained.

END OF SECTION 27 77 50
SECTION 27 77 80 – WARRANTY

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 SECTION INCLUDES

A. This section includes directions for the Contractor regarding system sign off and warranty.

1.3 SYSTEM DESCRIPTION

A. The project is not complete until all paperwork has been provided.

B. The Contractor shall warranty his work and all the products installed for a minimum of 1 year from day of Final completion.

1.4 COORDINATION

A. Coordinate as-built drawings and records with the Engineer and Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The Contractor shall provide the following to the Engineer prior to the issuance of the Notice of Final Completion.

1. Manuals and pamphlets on all electronic equipment.
2. All spare parts and coverplates for all components of the network.
3. Red lined set of as-built drawings for the entire project.
4. Updated hard copy and soft copy of the cable test spreadsheet.
5. Manufacturer warranty cards for all components.
6. Hard copy and soft copy of all electronic components broken out per closet, detailing their manufacturer, and their serial number.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall fully examine all components of the system to make sure that all manuals and paperwork are included in the final submittal.

3.2 PREPARATION

A. All binders for test results shall be neat and clearly labeled with listing of the tests included.

B. Prepare a list of the items in each closet or between closets that are not completed and a date when they will be completed.

3.3 PROJECT DELIVERABLES

A. All manuals and pamphlets shall be separated by equipment type.
B. All spare parts shall be provided in a box. The Contractor shall detail which component each spare part is for. Spare parts may include, but not limited to: blank covers for electronics, supports and mounting hardware.

C. The contractor shall provide two sets of as-built prints.
   1. The first set shall be a clean set of the latest drawings with red lines marked for all field changes or bulletins.
   2. The second set shall be a clean set of the latest drawings that have been updated with the information. These drawings shall be generated from an AutoCAD file that is provided by the engineer. The drawing shall include:
      3. Changes to be reflected on the drawings for Cabling Systems shall include:
         a. Route of exterior conduits and exterior cabling
         b. Rack/cabinet locations.
         c. Faceplate locations
         d. Rack layout of all components in each rack.
         e. Changes to the schematic connectivity of any system shown on the drawings.
         f. Cable numbering for each faceplate. Add this to the updated drawing and the AutoCAD file

D. Test results shall be supplied and submitted. Submit in hard and soft copy for all cable tests. Include software to read the test results

E. The manufacturer of all electronics provides a warranty on their product. The extent of that warranty is spelled out on cards provided in the box for each piece of equipment. These cards or pamphlets shall be provided to the Owner.

3.4 GENERAL WARRANTY

A. The Contractor shall warranty the installation and all the parts contained therein for a period of not less than 1 year after receipt of a completely signed copy of the Notice of Final Completion.

3.5 EXTENDED CABLING WARRANTY

A. The Contractor shall provide to the Owner a “Link Warranty” on all the components of the voice/data cabling system. This includes all components from the faceplate, through the jacks, cable, and back to the patch panels, not including patch cords.

B. Cable shall be installed that is covered as part of the complete warranty on the data cabling system. Cable that cannot be covered under the warranty shall not be installed.

C. The warranty shall be provided through the manufacturer of the faceplate, jacks, and patch panels. All components shall be by the same manufacturer.

D. The warranty shall guarantee that if any part or piece of the “Link” is found to be defective for a period of no less than 15 years, then that part or piece shall be replaced or fixed at no cost to the Owner.

E. The Contractor shall be responsible for installing the system in such a manner that the manufacturer will provide this warranty to the Owner.

F. The Contractor is responsible for compiling and submitting all the paperwork required to receive the warranty. This includes gathering all the information, completing any required forms, and submitting these forms and any other records to the manufacturer as required.

G. It shall be the Contractor’s responsibility to receive the approved warranty notification from the manufacturer and provide that and all the associated paperwork to the Owner.

H. The installation shall not be considered complete until the Owner has received notification, from the manufacturer, that the entire cabling system is covered by their warranty.

END OF SECTION 27 77 80
SECTION 28 31 00 – FIRE DETECTION AND ALARM

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 furnishing and installation of a complete and functional building fire detection and alarm system.

B. Division of Work:
   1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
      a. Electrical Subcontractor:
         1) Coordinate equipment.
         2) Install and wire all system components.
         3) Wire and install all duct smoke detectors. Coordinate location and control requirements with Temperature Control Subcontractor.
      b. Fire Alarm System Supplier: Test completed system.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of the Section shall comply with the following:
   1. NFPA Standards:
      c. NFPA 90A - Air Conditioning Systems.
      e. NFPA 13 - Installation of Sprinkler Systems.
      f. NFPA 17 - Dry Chemical Extinguishing Systems.
   2. UL Standards
      a. UL 864 - Control Units for Fire Protective Signaling Systems.
      b. UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
      c. UL 268A - Smoke Detectors for Duct Applications.
      e. UL 464 - Audible Signaling Appliances.
      f. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.
      g. UL 1971 - Signaling Devices for the Hearing-Impaired.
      h. UL 1481 - Power Supplies for Fire Protective Signaling Systems.
      i. UL 1635 - Digital Alarm Communicator System Units.
   4. Federal Codes and Regulations.
   5. Americans with Disabilities Act (ADA).
      a. ISO-9000.
      b. ISO-9001.

1.4 SYSTEM DESCRIPTION

A. Provide and install a new fire detection and alarm system with Remote LCD Annunciator and fire alarm system devices as indicated on Drawings and this specification.
1.5 DESIGN AND PERFORMANCE REQUIREMENTS

A. System shall be programmed to provide early detection of fire, to notify building occupants, notify Wayne State Campus Safety, override HVAC operation, and activate auxiliary systems to inhibit the spread of smoke and fire and to facilitate the safe evacuation of building occupants.

1.6 GENERAL

A. Upon the activation of any area smoke detector, duct type smoke detector, heat detector, manual pull station, sprinkler waterflow, the following functions shall automatically occur:
   1. The internal audible device shall sound at the control panel or command center.
   2. The LCD display shall indicate all applicable information associated with the alarm condition including zone, device type, device location, and time/date.
   3. All remote or local annunciator LCD/LEDs associated with the alarm zone shall be illuminated.
   4. Activate visual strobes and audible appliances on general alarm evacuation.
   5. The visual strobe shall continue to flash until the system has been reset. The visual strobe shall not stop operating when the “Alarm Silence” is pressed.
   6. All automatic events programmed to the alarm point shall be executed and the associated outputs activated.
   7. Transmit signal to the central station with point identification.
   8. Appropriate HVAC equipment shall be turned off until system is reset.
   9. All stairwell/exit doors shall unlock throughout the building.

1.7 DUCT TYPE SMOKE DETECTOR ALARM

A. Upon alarm activation of any duct type smoke detector the following functions shall automatically occur:
   1. The internal audible device shall sound at the control panel or command center.
   2. The LCD display shall indicate all applicable information associated with the alarm condition including zone, device type, device location, and time/date.
   3. All remote or local annunciator LCD/LEDs associated with the alarm zone shall be illuminated.
   4. Activate visual strobes and audible appliances on general alarm evacuation.
   5. The visual strobe shall continue to flash until the system has been reset. The visual strobe shall not stop operating when the “Alarm Silence” is pressed.
   6. All automatic events programmed to the alarm point shall be executed and the associated outputs activated.
   7. Transmit signal Wayne State Campus Safety with point identification.
   8. Appropriate HVAC equipment shall be turned off until system is reset.
   9. All stairwell/exit doors shall unlock throughout the building.

1.8 SUBMITTALS

A. Shop Drawings: For all system components.
   1. Data sheet indicating model number, performance specifications and dimensional data, color and finish.
   2. Details of construction and installation.
   3. Name of manufacturer.
   4. Full system schematic.
   5. Wiring details.
   6. Point-to-point wiring diagram showing all equipment.
   7. Battery calculations.
   8. Floor plan indicating fire alarm system devices only.
   9. Dimension plan indicating all items located inside fire alarm control panel. Plan should indicate future space.
   10. Indicate all features indicated in this specification which are not included in the manufacturer’s equipment. Label these items as “Exceptions to the Specifications”.

B. Layout drawings (plans) identifying all fire detection and alarm system devices. Plans shall be to scale and indicate mounting height for each device.
1.9 QUALITY ASSURANCE

A. Fabrication and Installation Personnel Qualifications:
   1. Trained and experienced in the fabrication and installation of the materials and equipment.
   2. Knowledgeable of the design and the reviewed submittals.
   3. NICET Level 2 certified.

B. Manufacturer:
   1. At least 5 years experience with approved systems.
   2. Having authorized service facility within 60 miles of Site.

C. Components: All components shall be UL listed for intended use.

D. Manufacturer's Services:
   1. Manufacturer's Certificate:
      a. Submit for installed system.
      b. Required Assurances:
         1) Confirmation of final inspection.
         2) Installation conforms to Specifications and Manufacturer's requirements.
   2. Provide Owner training program.

1.10 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.

B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.

C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.

D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected material with new materials at no additional cost to Owner.

1.11 WARRANTY

A. The Contractor shall warranty all materials, installation and workmanship for 1 year from date of acceptance, unless otherwise specified.

B. A copy of the Manufacturer's warranty shall be provided with close-out documentation and included with the operation and installation manuals.

C. The System Supplier shall maintain a service organization with adequate spare parts stock within 60 miles of the installation.

D. Any defects that render the system inoperative shall be repaired within 24 hours of the owner notifying the contractor.

1.12 CLOSE OUT

A. Close out submittals shall include:
   1. Project specific operating manuals covering the installed fire detection and alarm system.
   2. Manufacturer's data sheets and installation manuals/instructions for all equipment supplied.
   3. Owner's instruction and operation manual.
   4. Record drawings consisting of: a scaled plan of each building showing the placement of each individual item of the fire detection and alarm system as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway.
   5. All drawings must reflect point to point wiring.
6. All drawings shall be provided in standard .DXF format. A vellum plot of each sheet shall also be provided.
7. The application program listing for the system as installed at the time of acceptance by the building owner and/or local AHJ (disk, hard copy printout, and all required passwords).
8. Provide the name, address, and telephone of the authorized factory representative.
9. A filled out Record of Completion similar to NFPA 72, 1999 edition figure 1-6.2.1.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Provide products manufactured by one of the following Manufacturers:
   1. Siemens Energy & Automation, Inc.
   2. Simplex.
   4. No alternates will be acceptable.

2.2 CONTROL PANEL

A. The control panel(s) shall be a multi-processor based networked system designed specifically for fire, one-way and two-way emergency audio communications, smoke control.
B. The control panel shall include all required hardware, software and site specific system programming to provide a complete and operational system.
C. The control panel shall include the following circuits:
   1. Class B initiating device circuits.
   2. Class B signaling line circuits.
   3. Class B notification appliance circuits.
D. The control panel(s) operational priority shall assure that life safety takes precedence among the activities coordinated by the control panel.
E. The control panel(s) shall be semi-recessed surface mounted.
F. The control panel(s) shall be beige.
G. The control panel shall include the following capacities:
   1. Support up to 2,500 analog/addressable points.
   2. Support network connections up to 63 other control panels and annunciators.
   3. Support multiple digital dialers and modems
   4. Support multiple communication ports and protocols
   5. Support up to 1,740 chronological events.
   6. The control panel shall include the following features:
      a. Ability to download all network applications and firmware from the configuration computer from the configuration computer from a single location on the system.
      b. Provide electronic addressing of analog/addressable devices.
      c. Provide an operator interface control/display that shall annunciate, command and control system functions.
      d. Provide an internal audible signal with different programmable patterns to distinguish between alarm, supervisory, trouble and monitor conditions.
      e. Provide a discreet system control switch provided for reset, alarm silence, panel silence, drill switch, previous message switch, next message switch, and details switch.
      f. Provide system reports that provide detailed description of the status of system parameters for corrective action or for preventative maintenance programs. Reports shall be displayed by the operator interface or capable of being printed on a printer.
      g. Provide an authorized operator with the ability to operate or modify system functions like system time, date, passwords, holiday dates, restart the system and clear control panel event history file.
7. The control panel shall contain a standby power supply that automatically supplies electrical energy to the system upon primary power supply failure. The system shall include a charging circuit to automatically maintain the electrical charge of the battery.

8. Operator's Interface/Display:
   a. The system shall allow network functions to be configured to apply to any combination of (panels) in the network
   b. Each control panel(s) (network node) shall be capable of supporting a printer. All system control panel printer ports shall be configurable to output any combination of alarm, supervisory, trouble, monitor, or service group event messages.
   c. Each control panel(s) shall be capable of supporting a LCD display. The display on each panel shall be configurable to display the status of any and all combinations of all alarm, supervisory, trouble, monitor, or service group event messages.
   d. From each LCD display on the system shall be capable of being programmed for control functions of any node or the entire network. The LCD display shall reside on the network as a node and continue to operate with any fault on the network. An LCD shall be capable of being programmed to only be operational when a node is in stand alone mode, with a network fault.
   e. The system program shall have a minimum of 100 system definable service groups definable within the program to allow facilitate the testing of installed system based on the physical layout of the system. Service groups that disable the wiring of circuits serving multiple floors or fire zones shall not be considered as equal.
   f. The operator display shall clearly identify unacknowledged and acknowledged alarm, supervisory, trouble, and monitor status messages.
   g. The system shall provide the ability to download data from the analog/addressable detectors to a PC while the system is on-line and operational in the protected premises. The downloaded data may then be analyzed in a diagnostic program supplied by the system manufacturer.
   h. A standby power supply shall automatically supply electrical energy to the system upon primary power supply failure.

9. Annunciation:
   a. The system shall be designed and equipped to receive, monitor, and annunciate signals from devices and circuits installed throughout the building.
   b. Standard LED annunciators may be combined in common enclosures provided that the groups of LED's comprising each of the required annunciators are separated from one another (Detection, Supervisory, Status, and Status) and clearly labeled.
   c. Manufacturers' standard control switches shall be acceptable if they provide the required operation, including performance, supervision, and position indication. If the manufacturers' standard switches do not comply with these requirements, fabrication of custom manual controls acceptable to the Owner is required.
   d. Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel(s) and at each remote annunciation device. The integral audible devices shall produce a sound output upon activation of not less than 85 dBA at 10 feet.
   e. The annunciator shall contain the following system status indicators:
      1) 168 character backlit Liquid Crystal Display
      2) System Normal Indicator
      3) System Common Alarm Indicator
      4) System Common Trouble Indicator
      5) System Common Supervisory Indicator
      6) System Ground Fault Indicator
      7) System Common Security Indicator
      8) System Disabled Point(s) Indicator
      9) System Reset Switch with Indicator
     10) System Alarm Silence Switch with Indicator
     11) System Trouble Silence Switch with Indicator
     12) System Message Queue Scroll Switches.
     13) 10-Digit Keypad to Enable/Disable System and Functions.
   f. The LED annunciator rows shall contain the following format:
      1) Provide one row of red (alarm) and yellow (trouble) LED's. LED's in each row shall be arranged in columns, one column per type of alarm initiating device, and shall illuminate upon receipt of an alarm signal from the associated device(s) (i.e., electrical room smoke detector).
2) Provide one row of red (alarm) LED's. LED's in each row shall be arranged in columns, one column per type of alarm initiating device, and shall illuminate upon receipt of an alarm signal from the associated device(s) (i.e., electrical room smoke detector).

3) Provide one row of yellow (supervisory) LED's. LED's in each row shall be arranged in columns, one column per type of supervisory type device, and shall illuminate upon receipt of an supervisory signal from the associated device(s) (i.e., 2nd floor sprinkler valve supervisory switch).

4) The LED annunciator shall be provided with 25% spare LED's minimum. Each pair of LED's shall be labeled "Spare".

10. DACT Dialer:
   a. The system shall provide off premise communications capability using a digital alarm communications transmitter (DACT) for sending system events to multiple central monitoring station (CMS) receivers.
   b. The system shall provide the CMS(s) with point identification of system events using Contact ID or SIA DCS protocols.
   c. The system shall also transmit an alphanumeric system activity message, by event, to a commercial paging system of the owner's choice, using TAP Pager protocol.
   d. The system shall provide an individual CMS account for each tenant, and send the required signals to the one or more CMS(s) and account(s) specified by each tenant. In the event of a panel CPU failure during a fire alarm condition, the DACT degrade mode shall transmit a general fire alarm signal to the CMS.

11. Power Supply:
   a. System power supply(s) shall provide multiple power limited 24 VDC output circuits as required by the panel.
   b. Upon failure of normal (AC) power, the affected portion(s) of the system shall automatically switch over to secondary power without losing any system functions.
   c. Each system power supply shall be individually supervised. Power supply trouble signals shall identify the specific supply and the nature of the trouble condition.
   d. All standby batteries shall be continuously monitored by the power supply. Low battery and disconnection of battery power supply conditions shall immediately annunciated as battery trouble and identify the specific power supply affected.
   e. 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.
   f. All AC power connections shall be to the building's designated emergency electrical power circuit and shall meet the requirements of NFPA 72. The AC power circuit shall be installed in conduit raceway. The power circuit disconnect means shall be clearly labeled FIRE ALARM CIRCUIT CONTROL and shall have a red marking. The location of the circuit disconnect shall be labeled permanently inside the each control panel the disconnect serves.

12. Reports:
   a. The system shall provide the operator with system reports that give detailed description of the status of system parameters for corrective action, or for preventative maintenance programs.
   b. The system shall provide these reports via the main LCD, and shall be capable of being printed on any system printer.
   c. The system shall provide a report that gives a sensitivity listing of all detectors that have less than 75% environmental compensation remaining. The system shall provide a report that provides a sensitivity (% Obscuration per foot) listing of any particular detector.
   d. The system shall provide a report that gives a listing of the sensitivity of all the detectors on any given panel in the system, or any given analog/addressable device loop within any given panel.
   e. The system shall provide a report that gives a chronological listing of up to the last 1,740 system events.
   f. The system shall provide a listing of all of the firmware revision listings for all of the installed network components in the system.
2.3 INITIATING DEVICES

A. Addressable Smoke Detectors – Advanced Addressable:
   1. The detectors shall be guaranteed in writing not to false alarm when configured by the factory trained certified technician. The detectors must provide at least 19 different environmental algorithms that allow the detector to provide superior false alarm immunity without the need for additional alarm verification delays.
   2. The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.
   3. Detectors shall utilize state of the art forward/backward light scattering technology, with improved detection for smoldering and flaming fire signatures. The detectors shall replace the need for ionization detectors due to improved response characteristics to flaming fires.
   4. Detectors shall provide pre-alarm signal at 0.2% obscuration/ft. and a full alarm at 1.0% obscuration/ft. to meet the performance requirements of National Fire Protection Association Standard 76, Fire Protection of Telecommunications Facilities as a Very Early Warning Fire Detector (VEWFD).
   5. The forward/backward light scattering technology shall provide improved immunity to spurious activation (deceptive phenomena). The detectors shall have a “No False Alarm Guarantee”.
   6. The detectors shall be RoHS-compliant: it shall meet standards for Reduction of Hazardous Substances (RoHS) by reduction in lead content and other restricted substances.
   7. The multi-criteria fire detectors shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in-duct installation and sampling assembly installation and shall be insensitive to air velocity changes. The detectors’ communications shall allow the detectors to provide alarm input to the system and alarm output from the system within four (4) seconds. So as to minimize the effort required by the installing and maintenance technician to appropriately configure the detector to ensure optimal system design, the detectors shall be programmable as application specific. Application settings shall be selected in software for a minimum of 19 environmental fire profiles unique to the devices installed location.
   8. The detectors shall be designed to eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.
   9. The detectors shall be UL listed for operation in a 95% relative humidity (RH) environment.
   10. The detectors shall be designed to eliminate calibration errors associated with field cleaning of the chamber.
   11. The detectors shall support the use of a relay, or LED remote indicator without requiring an additional software address. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.
   12. The detectors shall support the use of an ambient temperature warning signal at the panel. This temperature shall be user-configurable for the set temperature of the warning and the event type generated by the warning. This event can be used to trigger system logic.
   13. For the detectors where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.
   14. UL Listed as “direct in-duct” mounting.
   15. Available Models: Multi-Criteria incorporating 2 Optical sensors and 2 Thermal sensors with an operating temperature range of 32 degrees F to 120 degrees F. Nineteen selectable profiles. Polarity insensitive installation wiring. Three color LED.

B. Addressable Smoke Detectors – Standard Addressable:
   1. The detector shall be guaranteed in writing not to false alarm when configured by the factory trained certified technician. The detector must provide up to 11 different environmental algorithms that allow the detector to provide superior false alarm immunity without the need for additional alarm verification delays.
   2. The detector shall have a multicolor LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.
3. The multi-criteria smoke detector shall be an intelligent digital photoelectric detector with a programmable heat sensor. Detectors shall be listed for use as open area protective coverage, in duct installation, and sampling assembly installation and shall be insensitive to air velocity changes. The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within 4 seconds. So as to minimize the effort required by the installing and maintenance technician to appropriately configure the detector to ensure optimal system design, the detectors shall be programmable as application specific. Application settings shall be selected in software for a minimum of eleven environmental fire profiles unique to the devices installed location.

4. The detector shall be designed to eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes, and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.

5. The intelligent smoke detector shall be capable of providing three distinct outputs from the control panel. The outputs shall be from an input of smoke obscuration, a thermal condition or a combination of obscuration and thermal conditions. The detector shall be designed to eliminate calibration errors associated with field cleaning of the chamber.

6. The detector shall support the use of a relay, or LED remote indicator without requiring an additional software address. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.

7. For the detector where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.

8. Where required, there shall be available a programmable remote lamp configurable to remotely duplicate the on-board LED status of another system device.

C. Smoke Detectors: Separate mounting base and detachable sensor head.

D. Duct Detector Housing:
1. Provide smoke detector duct housing assemblies with air sampling tube sized for duct location to mount an analog addressable detector.
2. Mounting base with auxiliary relay.
3. Provide remote alarm LED indicators and remote test station for each duct type smoke detector.
4. Wired and installed by Electrical Subcontractor. Coordinate exact location with Mechanical Subcontractor.

E. Heat Detectors:
1. Analog/Addressable Combination, Fixed Temperature/Rate of Rise:
   a. Fixed Temperature: 135 degrees F (57 degrees C).
   b. Rate of Rise: 15 degrees F (9 degrees C) per minute.
   c. Analog/Addressable Fixed Temperature: 200 degrees F (94 degrees C).
   d. Heat detector spacing shall comply with NFPA and Manufacturer’s listing.
   e. Provide fixed temperature 200 degrees F for boiler rooms.

F. Detector Bases: Provide standard detector mounting bases suitable for mounted on 1-gang, 3-1/2-inch or 4-inch octagon box, and 4-inch square box.

G. Manual Pull Stations: Shall be analog/addressable, single action double action, single stage, recessed pull-lever, break glass, open circuit type. Finish of the station to be red with lettered instructions “PULL IN CASE OF FIRE.”

H. Fire Protection Water Flow Switches and Valve Tamper Switches: For each existing switch, provide addressable module to monitor status of switch.

I. Combination Smoke/Fire Dampers:
1. To be provided by Mechanical Subcontractor in accordance with Division 21.
2. For each combination smoke fire damper, provide duct type smoke detector or area smoke detector with auxiliary contacts or addressable control module to initiate respective damper to close.
3. To control multiple smoke/fire dampers together, provide additional 20A relays as required.
J. Addressable Relays/Monitor and Control Modules: Form C normally open/normally closed dry relay contacts rated at 24VDC at 2 amps.
   1. Provide at least 2 contacts for transmitting signals to the WSU Campus Safety.

2.4 NOTIFICATION APPLIANCES

A. Low Profile Horn Strobes/Low Profile Strobes:
   1. Provide wall mounted horn/strobe with audible output of 84dBA at 10 feet.
   2. Horn shall have a selectable steady or synchronized temporal output and shall be wired separately from strobes.
   3. Strobes shall provide synchronized flash outputs.
   4. Wall mounted strobe Candela ratings of 15cd, 30cd, 60cd, 75cd, 110cd. Candela ratings shall be determined by equipment supplier.
   5. Ceiling mounted strobe Candela ratings of 15cd, 30cd, 75cd, 90cd, 115cd, 150cd, and 177cd Candela ratings shall be determined by equipment supplier.
   6. Provide weatherproof enclosures for exterior applications.

PART 3 - EXECUTION

3.1 WIRING

A. All wiring shall be in accordance with Manufacturer’s written recommendations and shall meet all applicable code requirements.

B. All wiring shall be copper.

C. No. 16 AWG minimum for signaling line circuits (SLCs)

D. No. 14 AWG THHN minimum for audible and visual notification appliance circuits (NACs).

E. No. 12 AWG THHN minimum for line voltage.

F. Install wiring completely in metal raceways in accordance with Division 26 Section “Raceways for Electrical Systems.”

G. Install wiring partially in metal raceways in accordance with Division 26 Section “Raceways for Electrical Systems.”

H. Cable type shall be FPLP, FPLR.

3.2 EQUIPMENT INSTALLATION


B. Duct Smoke Detectors: Connect each duct detector to fire alarm system so upon sensing smoke, fire alarm system goes into alarm. Coordinate location with Mechanical Subcontractor.

C. Smoke Detectors: Install detectors indicated to be ceiling mounted not less than 4 inches from a side wall to the near edge. Install detectors located on the wall at least 4 inches but not more than 12 inches below the ceiling. For exposed solid joist construction, mount detectors on the bottom of the joists. On smooth ceilings, install detectors not over 30 feet apart in any direction. Install detectors no closer than 5 feet from air registers.
   1. Utilize standard addressable smoke detectors for all applications except the areas subject to vehicular traffic. Vehicular traffic locations shall utilize advance addressable style.
D. Audio/Visual Alarm Indicating Devices: Mount at 80 inches above the highest floor level within space or 6 inches below the ceiling, whichever is lower. Unless otherwise indicated, install bells and horns on flush-mounted back boxes with the device operating mechanism concealed behind a grille. Combine audible and visible alarms at the same location into a single unit.

E. Fire Alarm Panel (FAP): Top of cabinet not more than 6 feet above the finished floor.

F. Remote Annunciator: Locate as indicated on the Drawings unless an alternate location is requested by the Authority having jurisdiction.

G. Smoke Dampers: All smoke dampers shall close upon sensing smoke from a smoke or duct detector. The HVAC unit shall be shut down upon activation. A smoke or duct detector shall be provided for each smoke damper.

3.3 GROUNDING

A. Ground equipment and conductor and cable shields. For audio circuits, minimize to the greatest extent possible ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5 ohm ground at main equipment location. Measure, record, and report ground resistance.

3.4 FIELD QUALITY CONTROL

A. All intelligent analog addressable devices shall be tested for current address, sensitivity, and user defined message.

B. All wiring shall be tested for continuity, shorts, and grounds before the system is activated.

C. All test equipment, instruments, tools, and labor required to conduct the tests shall be made available by the installing contractor.

D. The system including all its sequence of operations shall be demonstrated to the Owner, his representative, and the local fire inspector. In the event the system does not operate properly, the test shall be terminated. Corrections shall be made and the testing procedure shall be repeated until it is acceptable to the Owner, his representatives and the fire inspector.

E. At the final test and inspection, a factory trained representative of the system manufacturer shall demonstrate that the system functions properly in accordance with these specifications. The representative shall provide technical supervision, and participate during all of the testing for the system.

F. All fire alarm testing shall be in accordance with National Fire Alarm Code, NFPA 72 - 1999, Chapter 7.

G. A letter from the Contractor certifying that the system is installed entirely in accordance with the system manufacturer's recommendations and within the limitations of the required listings and approvals, that all system hardware and software has been visually inspected and functionally tested by a manufacturer's certified representative, and that the system is in proper working order.

END OF SECTION 28 31 00