PROJECT MANUAL

Volume Two

Renovate Mechanical/Electrical/Life Safety

Jefferson State Office Building

205 Jefferson Street

Jefferson City, Missouri

Designed By: McClure Engineering
1000 Clark Ave
St. Louis, MO 63102

Date Issued: August 31, 2023

Project No.: O1911-01

STATE *of* MISSOURI

OFFICE *of* ADMINISTRATION

Facilities Management, Design & Construction

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1.2 SUMMARY

A. This Section provides a comprehensive list of the drawings that comprise the Bid Documents for this project.

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PART 3 - EXECUTION

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166	ONE-LINE DEMOLITION	ED0.1	8/31/2023
167	BASEMENT FLOOR PLAN - DEMOLITION	ED1.0	8/31/2023
168	FIRST FLOOR PLAN- DEMOLITION	ED1.1	8/31/2023
169	SECOND FLOOR PLAN - DEMOLITION	ED1.2	8/31/2023
170	THIRD FLOOR PLAN - DEMOLITION	ED1.3	8/31/2023
171	FOURTH FLOOR PLAN - DEMOLITION	ED1.4	8/31/2023
172	FIFTH FLOOR PLAN - DEMOLITION	ED1.5	8/31/2023
173	SIXTH FLOOR PLAN - DEMOLITION	ED1.6	8/31/2023
174	SEVENTH FLOOR PLAN - DEMOLITION	ED1.7	8/31/2023
175	EIGHTH FLOOR PLAN - DEMOLITION	ED1.8	8/31/2023
176	NINTH FLOOR PLAN - DEMOLITION	ED1.9	8/31/2023
177	TENTH FLOOR PLAN - DEMOLITION	ED1.10	8/31/2023
178	ELEVENTH FLOOR PLAN - DEMOLITION	ED1.11	8/31/2023
179	TWELFTH FLOOR PLAN - DEMOLITION	ED1.12	8/31/2023
180	THIRTEENTH FLOOR PLAN - DEMOLITION	ED1.13	8/31/2023
181	FOURTEENTH FLOOR PLAN - DEMOLITION	ED1.14	8/31/2023
182	ROOF AND PENTHOUSE FLOOR PLANS - DEMOLITION	ED1.15	8/31/2023
	ELECTRICAL - GENERAL		
183	SYMBOLS AND ABBREVIATIONS	E0.0	8/31/2023
184	LUMINAIRE SCHEDULE AND DETAILS	E0.1	8/31/2023
185	LIGHTING CONTROLS MATRIX AND DETAILS	E0.2	8/31/2023
186	ONE-LINE NEW WORK	E0.3	8/31/2023
187	POWER SCHEDULES DIAGRAMS AND DETAILS	E0.4	8/31/2023
188	MECHANICAL/ELECTRICAL SCHEDULE	E0.5	8/31/2023
189	FIRE ALARM RISER DIAGRAM	E0.6	8/31/2023
190	DATA RISER DIAGRAM	E0.7	8/31/2023
191	AUDIO - VISUAL DETAILS	E0.8	8/31/2023
192	AUDIO - VISUAL DETAILS	E0.9	8/31/2023
193	AUDIO - VISUAL DETAILS	E0.10	8/31/2023
	LIGHTING		
194	BASEMENT FLOOR PLAN - LIGHTING	E1.0	8/31/2023

195	FIRST FLOOR PLAN- LIGHTING	E1.1	8/31/2023
196	ALTERNATE BIDS FIRST FLOOR PLAN - LIGHTING	E1.1ALT	8/31/2023
197	SECOND FLOOR PLAN - LIGHTING	E1.2	8/31/2023
198	THIRD FLOOR PLAN - LIGHTING	E1.3	8/31/2023
199	FOURTH FLOOR PLAN - LIGHTING	E1.4	8/31/2023
200	FIFTH FLOOR PLAN - LIGHTING	E1.5	8/31/2023
201	SIXTH FLOOR PLAN - LIGHTING	E1.6	8/31/2023
202	SEVENTH FLOOR PLAN - LIGHTING	E1.7	8/31/2023
203	EIGHTH FLOOR PLAN - LIGHTING	E1.8	8/31/2023
204	NINTH FLOOR PLAN - LIGHTING	E1.9	8/31/2023
205	TENTH FLOOR PLAN - LIGHTING	E1.10	8/31/2023
206	ELEVENTH FLOOR PLAN - LIGHTING	E1.11	8/31/2023
207	TWELFTH FLOOR PLAN - LIGHTING	E1.12	8/31/2023
208	THIRTEENTH FLOOR PLAN - LIGHTING	E1.13	8/31/2023
209	FOURTEENTH FLOOR PLAN - LIGHTING	E1.14	8/31/2023
210	ROOF AND PENTHOUSE FLOOR PLANS - LIGHTING	E1.15	8/31/2023
	POWER & DATA		
211	BASEMENT FLOOR PLAN - POWER AND DATA	E2.0	8/31/2023
212	FIRST FLOOR PLAN - POWER AND DATA	E2.1	8/31/2023
213	ALTERNATE BIDS FIRST FLOOR PLAN - POWER AND DATA	E2.1ALT	8/31/2023
214	SECOND FLOOR PLAN - POWER AND DATA	E2.2	8/31/2023
215	THIRD FLOOR PLAN - POWER AND DATA	E2.3	8/31/2023
216	FOURTH FLOOR PLAN - POWER AND DATA	E2.4	8/31/2023
217	FIFTH FLOOR PLAN - POWER AND DATA	E2.5	8/31/2023
218	SIXTH FLOOR PLAN - POWER AND DATA	E2.6	8/31/2023
219	SEVENTH FLOOR PLAN - POWER AND DATA	E2.7	8/31/2023
220	EIGHTH FLOOR PLAN - POWER AND DATA	E2.8	8/31/2023
221	NINTH FLOOR PLAN - POWER AND DATA	E2.9	8/31/2023
222	TENTH FLOOR PLAN - POWER AND DATA	E2.10	8/31/2023
223	ELEVENTH FLOOR PLAN - POWER AND DATA	E2.11	8/31/2023
224	TWELFTH FLOOR PLAN - POWER AND DATA	E2.12	8/31/2023
225	THIRTEENTH FLOOR PLAN - POWER AND DATA	E2.13	8/31/2023
226	FOURTEENTH FLOOR PLAN - POWER AND DATA	E2.14	8/31/2023
227	ROOF AND PENTHOUSE FLOOR PLANS - POWER AND DATA	E2.15	8/31/2023
	SYSTEMS		
228	BASEMENT FLOOR PLAN - SYSTEMS	E3.0	8/31/2023
229	FIRST FLOOR PLAN - SYSTEMS	E3.1	8/31/2023
230	ALTERNATE BIDS FIRST FLOOR PLAN - SYSTEMS	E3.1ALT	8/31/2023
231	SECOND FLOOR PLAN - SYSTEMS	E3.2	8/31/2023
232	THIRD FLOOR PLAN - SYSTEMS	E3.3	8/31/2023
233	FOURTH FLOOR PLAN - SYSTEMS	E3.4	8/31/2023

234	FIFTH FLOOR PLAN - SYSTEMS	E3.5	8/31/2023
235	SIXTH FLOOR PLAN - SYSTEMS	E3.6	8/31/2023
236	SEVENTH FLOOR PLAN - SYSTEMS	E3.7	8/31/2023
237	EIGHTH FLOOR PLAN - SYSTEMS	E3.8	8/31/2023
238	NINTH FLOOR PLAN - SYSTEMS	E3.9	8/31/2023
239	TENTH FLOOR PLAN - SYSTEMS	E3.10	8/31/2023
240	ELEVENTH FLOOR PLAN - SYSTEMS	E3.11	8/31/2023
241	TWELFTH FLOOR PLAN - SYSTEMS	E3.12	8/31/2023
242	THIRTEENTH FLOOR PLAN - SYSTEMS	E3.13	8/31/2023
243	FOURTEENTH FLOOR PLAN - SYSTEMS	E3.14	8/31/2023
244	ROOF AND PENTHOUSE FLOOR PLANS - SYSTEMS	E3.15	8/31/2023

END OF SECTION 000115

SECTION 20 08 00 – SEISMIC PROTECTION

PART 1 - GENERAL

1. RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Specification Sections, apply to this and the other sections of Division 20-28

2. SEISMIC RESTRAINT

A. All materials and workmanship shall specifically comply with the above listed Building Code with respect to seismic requirements for the support and anchorage of all mechanical systems and equipment as installed on this project. Lateral forces to be restrained shall be as required by ASCE 7 Section 11 and 13 Architectural, Mechanical, and Electrical Components and Systems. Refer to structural drawings and/or Geotechnical Report for design values.

-Site Class (ASCE 7-05, Table 11.4-1 and 11.4-2)	**D**
- Seismic Use Group	**III**
- Seismic Design Category	**D**
- Spectral Acceleration, Short period (S_{DS})	**.206**

B. All piping support and restraint details and practices shall conform to the publication "Seismic Restraint Manual Guidelines for Mechanical Systems" by SMACNA, 2008 Edition, and/or "Seismic Restraints" by B-Line systems, Inc.

C. DELEGATED DESIGN: Design hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, herein referred to as Seismic engineer. Prepare drawings, calculations and details for any anchorage, bracing and/or sway bracing for seismic restraint as required by the local codes and Authority Having Jurisdiction. Seismic engineer shall inspect the final installation for compliance with the approved Seismic shop drawings. Seismic engineer to identify items that need to be corrected or changed and provide contractor additional/revised drawings as required.

D. SUBMITTALS:
1. SHOP DRAWINGS: Submit drawings, calculations and details shall be signed and sealed by a Professional Engineer licensed in the State of the Project's location.
2. CLOSEOUT: As-built seismic drawings with Letter from Seismic engineer stating that the completed installation meets the design.

E. INSTALLATION: Contractor shall only use those materials submitted and approved. Contractor shall notify Seismic Engineer when actual installation differs from the approved Seismic shop drawing.

END OF SECTION 200800

SECTION 21 01 00 – BASIC FIRE PROTECTION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Specification Sections, apply to this and the other sections of Division 21.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for fire protection installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:

1. Submittals.

2. Material and Equipment Selection.

3. Coordination drawings.

4. Record documents.

5. Maintenance manuals.

6. Buy American Act Provision

1.3 REFERENCED STANDARDS

A. International Fire Code 2018 (IFC)

B. National Fire Protection Association Standards

1.4 CONTRACTOR'S SUBMITTAL REVIEW RESPONSIBILITIES

A. General: Submittals are not requested for all products covered in the specifications. Submit only the data requested under the submittals portion of each specification section or where indicated in a Submittal Log, if included within Division 01. Un-requested submittals will not be processed, reviewed or returned and the contractor will be notified that the submittal will not be reviewed by the engineer of record.

1. Non-requirement of submittals, when so noted, is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.

2. Any deviation from specified items is considered a substitution. If the contractor desires to use other than specified items, then a formal request for substitution must be submitted prior to bid date (no exceptions), in accordance with the procedures and time limitations set forth in

Division 01. Where not defined in Division 01, requests for substitutions shall be submitted no less than ten (10) working days prior to bid date. Review of substitution requests by the Engineer shall be done at the expense of the contractor. Charges for this substitution review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

B. It is the responsibility of the Contractor to ensure that all submittals have been reviewed for total completeness and accuracy as to the requirements of the specifications and drawings before being submitted to the Engineer for review.

1. One comprehensive submittal shall be provided for each individual specification section. All required submittal information called for in each individual specification section shall be included in the submittal.

2. The Engineer of Record shall not be responsible for informing the contractor on items that have not been included and are necessary for a complete review of the required submittal information for a specification section.

3. The Engineer of Record shall have the option of returning any submittal, unmarked, if all required documentation called for in the specifications has not been provided in the submittal.

4. The Engineer of Record shall review each submittal no more than two (2) times and return to the contractor with the appropriate disposition.

5. If the Engineer of Record is required to review a submittal a second time, it shall be limited to review of the changed information, clearly highlighted by the submitter, and/or confirmation of documentation only and it shall be returned to the contractor with the appropriate disposition.

6. If the submittal is required to be reviewed a third time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

C. Operation and Maintenance Manuals: All items required for insertion into each Operation and Maintenance (O&M) Manual are called out in the submittals portion of each specification section or in a Submittal Log, if included within Division 01. It is the responsibility of the Contractor to ensure that the O&M submittal has been reviewed and includes all the requirements of the specifications. The Engineer of Record shall review the submittal for the Operation and Maintenance Manual one (1) time and return to the contractor with the appropriate disposition.

1. If the submittal is required to be reviewed a second time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

2. Submittals for the Operation and Maintenance Manual must be original documentation.

3. Photo copies of marked up Operations and Maintenance submittals are not acceptable.

D. Refer to Division 01 and each individual Division 21 Section for additional submittal requirements.

E. Prepare maintenance manuals in accordance with Division 01. In addition to the requirements specified in Division 01, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

5. Facsimiles or photo copies are not allowed as submittals for operating and maintenance manuals. Submittals for operating and maintenance manuals must be on original manufacturer printed stock.

F. Prepare and submit Coordination Drawings as further described herein. The Engineer shall receive one copy of all coordination drawings supplied to the Owner as required in this specification. It is the responsibility of the Contractor to coordinate the work as outlined herein. Receipt by the Engineer of a copy of the coordination drawings is to verify conformance to the submittal requirements set forth in this specification section. It is not an admission by the Engineer as to the accuracy or completeness of the coordination proposed.

G. Coordination shall be drawn to a scale of ¼" = 1'0" or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement. Include all piping including but not limited to Fire Protection piping, HVAC piping, and Plumbing piping. Include ceiling and wall-mounted access doors and panels required to provide access to valves and other operating devices.

2. Planned ductwork layout, including terminal units, dampers and specialty locations, with terminal unit and damper operator clearances. Include ceiling and wall-mounted access doors and panels required to provide access to dampers and other operating devices.

3. Clearances for installing and maintaining insulation.

4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.

5. Equipment and accessory service connections and support details.

6. Exterior wall and foundation penetrations.

7. Fire-rated wall and floor penetrations.

8. Sizes and location of required concrete pads and bases.

9. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.

10. Floor plans, elevations, and details to indicate penetrations in floors, walls, ceilings and roofs, and their relationship to other penetrations and installations.

11. Ceiling plans showing coordination of mechanical, electrical, structural, ceiling suspension assembly, lighting, security, communications, fire alarm, plumbing, and fire protection work within allotted space.

12. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, access panels, special moldings, and other ceiling-mounted items.

13. Floor plans and sections of fan rooms and mechanical rooms; show layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

H. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located. Indicate actual inverts and horizontal locations of all underground piping.

2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

4. Contract Modifications, actual equipment and materials installed.

I. Comply with each individual Division 21 Section for additional submittal requirements.

1.5 MATERIAL AND EQUIPMENT SELECTION

A. Product Options: The specification of each item of major mechanical equipment required for the project may include a list of manufacturers, with one “basis of design” manufacturer, type, and model identified by virtue of their listing in the equipment schedule on the Drawings. Where several manufacturers in addition to the “basis of design” manufacturer are listed in the specifications, it shall be understood that the words “or approved equal by” are implied to precede each of the other manufacturer’s names.

1. The manufacturers other than the “basis of design” may be furnished at the contractor’s option in lieu of the “basis of design” product, provided that the selected manufacturer’s product is equal in all material and functional respects. In addition to submittal requirements that may be specified in this section, submit a line-by-line written verification of the applicable specification section(s) identifying compliance with or variations from the specified features, materials, performance, capacities, weight, size, durability, energy consumption and efficiency, warranty, and visual impact (if exposed to view by other than maintenance persons). The burden of proof of manufacturer/product equality is on the contractor.

2. Where a product is not scheduled on the drawings and, therefore, where no “basis of design” is indicated, selection among all of the listed manufacturers and products is at the contractor’s option, subject to the requirements of the Contract Documents.

3. Products of manufacturers not listed in the Contract Documents are considered Substitutions and are not permitted, except as provided under the General and Supplementary Conditions and Division 01 Specifications. Full compliance with Division 01 section “Product Substitutions” is mandatory for acceptance of products or manufacturers not listed.

B. Listing of a manufacturer does not imply approval of that manufacturer's standard product or products. Rather, listing of a manufacturer indicates only a general acceptance of that manufacturer's name and reputation. Final approval is subject to full compliance with these Contract Documents.

C. Model numbers identified on the Drawings notwithstanding, all equipment must comply with the requirements of these Contract Documents. Do not assume that a manufacturer's standard product is acceptable as is. For example, one or more custom modifications, custom colors or finishes, manufacturer's options, and/or accessories may be required to meet the specified requirements.

D. Where drawings indicate sizes, profiles, connections, and dimensional requirements of material and equipment, these are based on the "basis of design" manufacturer, type and model indicated. In the event that equipment of power, dimensions, capacities, layout, connections, and/or ratings differing from the "basis of design" are selected by the contractor and approved by the Owner's representative, any necessary adjustments are the contractor's responsibility. All connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, pipe and duct sizes, pipe and duct layout, and the like shall be adjusted by the contractor to suit the equipment provided. No additional costs will be approved for these changes. Should revisions to the design because of contractor's selection of manufacturer, type, or model other than the "basis of design" require additional review and/or redesign by an Architect or Engineer, the contractor shall reimburse the Owner for Owner's added professional fee expenses.

E. Where two or more materials are listed in the "Part 2 – Products" subsection of any Division 21 section, do not assume that the selection of materials is the contractor's option. Refer to "Part 3 – Execution" subsection of that same Division 21 section for an explanation of which specific material(s) shall be used for which specific application(s). For example, Part 2 may list several types and grades of piping, and Part 3 will describe which type and grade of pipe to use for a given application.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Protect stored on-site or installed absorptive materials from moisture damage. Materials directly exposed to moisture via precipitation, water leaks, or condensation shall be removed from the jobsite and replaced.

END OF SECTION 210100

SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.4 CONTRACTOR'S SUBMITTAL REVIEW RESPONSIBILITIES

A. General: Submittals are not requested for all products covered in the specifications. Submit only the data requested under the submittals portion of each specification section or where indicated in a Submittal Log, if included within Division 01. Un-requested submittals will not be processed, reviewed or returned and the contractor will be notified that the submittal will not be reviewed by the engineer of record.

1. Non-requirement of submittals, when so noted, is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.

2. Any deviation from specified items is considered a substitution. If the contractor desires to use other than specified items, then a formal request for substitution must be submitted prior to bid date (no exceptions), in accordance with the procedures and time limitations set forth in Division 01. Where not defined in Division 01, requests for substitutions shall be submitted no less than ten (10) working days prior to bid date. Review of substitution requests by the Engineer shall be done at the expense of the contractor. Charges for this substitution review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

B. It is the responsibility of the Contractor to ensure that all submittals have been reviewed for total completeness and accuracy as to the requirements of the specifications and drawings before being submitted to the Engineer for review.

1. One comprehensive submittal shall be provided for each individual specification section. All required submittal information called for in each individual specification section shall be included in the submittal.

2. The Engineer of Record shall not be responsible for informing the contractor on items that have not been included and are necessary for a complete review of the required submittal information for a specification section.

3. The Engineer of Record shall have the option of returning any submittal, unmarked, if all required documentation called for in the specifications has not been provided in the submittal.

4. The Engineer of Record shall review each submittal no more than two (2) times and return to the contractor with the appropriate disposition.

5. If the Engineer of Record is required to review a submittal a second time, it shall be limited to review of the changed information, clearly highlighted by the submitter, and/or confirmation of documentation only and it shall be returned to the contractor with the appropriate disposition.

6. If the submittal is required to be reviewed a third time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

C. Operation and Maintenance Manuals: All items required for insertion into each Operation and Maintenance (O&M) Manual are called out in the submittals portion of each specification section or in a Submittal Log, if included within Division 01. It is the responsibility of the Contractor to ensure that the O&M submittal has been reviewed and includes all the requirements of the specifications. The Engineer of Record shall review the submittal for the Operation and Maintenance Manual one (1) time and return to the contractor with the appropriate disposition.

1. If the submittal is required to be reviewed a second time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

2. Submittals for the Operation and Maintenance Manual must be original documentation.

3. Photo copies of marked up Operations and Maintenance submittals are not acceptable.

D. Coordination Drawings: Prepare and submit Coordination Drawings as further described herein and as indicated in the Special Conditions. The Engineer shall receive one copy of all coordination drawings supplied to the Owner as required in this specification. It is the responsibility of the Contractor to coordinate the work as outlined herein. Receipt by the Engineer of a copy of the coordination drawings is to verify conformance to the submittal requirements set forth in this specification section. It is not an admission by the Engineer as to the accuracy or completeness of the coordination proposed.

E. Refer to Division 01 and each individual Division 23 Section for additional submittal requirements.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Mechanical sleeve seals.

2. Escutcheons.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and

connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.8 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
e. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Carbon steel or Stainless steel. Include two for each sealing element.

3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type with spring clips.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
i. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

B. Field Welding: Comply with AWS D1.1.

END OF SECTION 210500

SECTION 21 10 00 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following fire-suppression piping inside the building:

1. Wet-pipe sprinkler systems.

B. Related Sections include the following:

1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.

2. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

1.3 DEFINITIONS

A. CPVC: Chlorinated polyvinyl chloride plastic.

B. CR: Chlorosulfonated polyethylene synthetic rubber.

C. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig.

D. PE: Polyethylene plastic.

E. Underground Service-Entrance Piping: Underground service piping below the building.

1.4 SYSTEM DESCRIPTIONS

A. Combined Standpipe and Sprinkler System: Fire-suppression system with both standpipe and sprinkler systems. Sprinkler system is supplied from standpipe system.

B. Manual Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has small water supply to maintain water in standpipes. Piping is wet, but water must be pumped into standpipes to satisfy demand.

C. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

D. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from opened sprinklers.

1.5 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.

B. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

2. Space Classification

1) Light Hazard:

Offices
Toilet Rooms
Lobby/Commons Area
Corridors
Meeting Rooms
Training Room
Multi-Purpose Rooms
Vestibules

2) Ordinary Hazard, Group 1:

Mechanical Rooms

3. Maximum Protection Area per Sprinkler: Per UL listing.

1.6 SUBMITTALS

A. Product Data: For the following:

1. Piping materials, including sprinkler specialty fittings.

2. Pipe hangers and supports**,** including seismic restraints.

3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.

4. Air compressors, including electrical data.

5. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.

6. Hose connections, including size, type, and finish.

7. Hose stations, including size, type, and finish of hose connections; type and length of fire hoses; finish of fire hose couplings; type, material, and finish of nozzles; and finish of rack.

8. Monitors.

9. Fire hydrants.

10. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.

11. Alarm devices, including electrical data.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Fire-hydrant flow test report.

D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13 and FM Global, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.

E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."

F. Field quality-control test reports.

G. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

1.8 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide number of sprinklers required by NFPA 13 and sprinkler wrench. Turn over heads to FMDC Maintenance Staff.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Schedule 40 Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
5. Steel Threaded Couplings: ASTM A 865.

B. Plain-End, Standard-Weight Schedule 40 Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795.

1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
2. Steel Flanges and Flanged Fittings: ASME B16.5.

C. Grooved-End, Standard-Weight Schedule 40 Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, square-cut or roll-grooved ends.

1. Grooved-Joint Piping Systems:

a. Manufacturers:

1) Anvil International, Inc.
2) Shurjoint Piping Products, Inc.
3) Victaulic Co. of America.
4) Ward Manufacturing.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

2.3 DIELECTRIC FITTINGS

A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.

B. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180 degrees F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Hart Industries International, Inc.
e. Watts Industries, Inc.; Water Products Div.
f. Zurn Industries, Inc.; Wilkins Div.

2.4 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed and FM Global approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.

B. Outlet Specialty Fittings:

1. Manufacturers:

a. Anvil International, Inc.
b. National Fittings, Inc.
c. Victaulic Co. of America.
d. Ward Manufacturing.

C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

1. Manufacturers:

a. Fire-End and Croker Corp.
b. Viking Corp.
c. Victaulic Co. of America.

D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

1. Manufacturers:

a. Elkhart Brass Mfg. Co., Inc.
b. Fire-End and Croker Corp.

c. Potter-Roemer; Fire-Protection Div.

E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

1. Manufacturers:

a. AGF Manufacturing Co.
b. Central Sprinkler Corp.
c. G/J Innovations, Inc.
d. Triple R Specialty of Ajax, Inc.

F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

1. Manufacturers:

a. CECA, LLC.
b. Merit.

2.5 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed and FM Global approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

B. Gate Valves with Wall Indicator Posts:

1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.

2. Manufacturers:

a. Grinnell Fire Protection.
b. McWane, Inc.; Kennedy Valve Div.
c. NIBCO.
d. Stockham.

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.

1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.

2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.

3. NPS 3: Ductile-iron body with grooved ends.

4. Manufacturers:

a. NIBCO.
b. Victaulic Co. of America.

D. Butterfly Valves: UL 1091.

1. NPS 2 and Smaller: Bronze body with threaded ends.

a. Manufacturers:

1) Global Safety Products, Inc.
2) Milwaukee Valve Company.

2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.

a. Manufacturers:

1) Global Safety Products, Inc.
2) McWane, Inc.; Kennedy Valve Div.
3) Mueller Company.
4) NIBCO.
5) Victaulic Co. of America.

E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

1. Manufacturers:

a. Clow Valve Co.
b. Globe Fire Sprinkler Corporation.
c. Grinnell Fire Protection.
d. Hammond Valve.
e. McWane, Inc.; Kennedy Valve Div.
f. Mueller Company.
g. NIBCO.
h. Potter-Roemer; Fire Protection Div.
i. Reliable Automatic Sprinkler Co., Inc.
j. Victaulic Co. of America.
k. Watts Industries, Inc.; Water Products Div.

F. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.

a. Manufacturers:

1) Crane Co.; Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) NIBCO.
4) United Brass Works, Inc.

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

a. Manufacturers:

1) Clow Valve Co.
2) Hammond Valve.
3) Milwaukee Valve Company.
4) Mueller Company.
5) NIBCO.
6) United Brass Works, Inc.

G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch or Electrical, 115-V ac, prewired, 2-circuit, supervisory switch.

2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.

    a. Manufacturers:

        1) Milwaukee Valve Company.
        2) NIBCO.
        3) Victaulic Co. of America.

3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.

    a. Manufacturers:

        1) Grinnell Fire Protection.
        2) McWane, Inc.; Kennedy Valve Div.
        3) Milwaukee Valve Company.
        4) NIBCO.
        5) Victaulic Co. of America.

2.6 SPRINKLERS

A. All sprinkler heads are to be quick response pendant style fusible link type, with a minimum of ½ inch orifice, ½ inch NPT, and a K factor of 5.65. Sprinklers have an orifice larger than ½ inch shall be ¾" NPT.
B. In finished spaces with ceilings, provide chrome escutcheon.

2.7 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

    1. Manufacturers:

        a. ADT Security Services, Inc.
        b. Grinnell Fire Protection.
        c. ITT McDonnell & Miller.
        d. Potter Electric Signal Company.
        e. System Sensor.
        f. Viking Corp.
        g. Watts Industries, Inc.; Water Products Div.

C. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

    1. Manufacturers:

        a. Grinnell Fire Protection.
        b. Potter Electric Signal Company.
        c. System Sensor.

d. Viking Corp.

D. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Manufacturers:

a. McWane, Inc.; Kennedy Valve Div.
b. Potter Electric Signal Company.
c. System Sensor.

2.8 PRESSURE GAGES

A. Manufacturers:

1. AGF Manufacturing Co.

2. AMETEK, Inc.; U.S. Gauge.

3. Brecco Corporation.

4. Dresser Equipment Group; Instrument Div.

5. Marsh Bellofram.

6. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of [0 to 250 psig minimum.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.

2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

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

3.3 PIPING APPLICATIONS, GENERAL

A. Shop weld pipe joints where welded piping is indicated.

B. Do not use welded joints for galvanized-steel pipe.

C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

D. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded joints.

E. Underground Service-Entrance Piping: Ductile-iron, mechanical-joint pipe and fittings and restrained joints. Include corrosion-protective encasement.

3.4 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:

1. NPS 2 and Smaller: Threaded-end, black, standard-weight Schedule 40 steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.

2. NPS 2-1/2 and larger: Grooved-end, black, standard-weight Schedule 40 steel pipe; grooved- end fittings; grooved-end-pipe couplings; and grooved joints.

3.5 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Listed Fire-Protection Valves: UL listed and FM Global approved for applications where required by NFPA 13 and NFPA 14.

a. Shutoff Duty: Use ball or butterfly valves.

3.6 JOINT CONSTRUCTION

A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.

B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe

smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.

C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.

1. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

2. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.

3.7 PIPING INSTALLATION

A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints.

D. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

F. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install drain valves on standpipes.

K. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

L. Install alarm devices in piping systems.

M. Hangers and Supports: Comply with NFPA 13 for hanger materials.

1. Install sprinkler system piping according to NFPA 13.

N. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.

O. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

P. Drain dry-pipe sprinkler piping.

Q. Pressurize and check dry-pipe sprinkler system piping, air-pressure maintenance devices, and air compressors.

R. Fill wet-standpipe system piping with water.

S. Fill wet-pipe sprinkler system piping with water.

3.8 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

D. Specialty Valves:

1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

2. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

    a. Air-Pressure Maintenance Devices for Dry-Pipe Systems: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.
    b. Install air compressor and compressed-air supply piping.
    c. Install compressed-air supply piping from building's compressed-air piping system.

3.9 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels and tiles.

B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.10 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.

D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

F. Electrical Connections: Power wiring is specified in Division 26.

G. Connect alarm devices to fire alarm.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

J. Tighten electrical connectors and terminals according to manufacturer's published torque- tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.11 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14.

3.12 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Energize circuits to electrical equipment and devices.

4. Start and run excess-pressure pumps.

5. Start and run air compressors.

6. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
7. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.

8. Coordinate with fire alarm tests. Operate as required.

9. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.13 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

C. Protect sprinklers from damage until Substantial Completion.

END OF SECTION 211000

SECTION 22 01 00 – BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Specification Sections, apply to this and the other sections of Division 22.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for plumbing installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:

1. Submittals.

2. Material and Equipment Selection.

3. Coordination drawings.

4. Record documents.

5. Maintenance manuals.

1.3 REFERENCED STANDARDS

A. International Plumbing Code 2015 (IPC)

1.4 CONTRACTOR'S SUBMITTAL REVIEW RESPONSIBILITIES

A. General: Submittals are not requested for all products covered in the specifications. Submit only the data requested under the submittals portion of each specification section or where indicated in a Submittal Log, if included within Division 01. Un-requested submittals will not be processed, reviewed or returned and the contractor will be notified that the submittal will not be reviewed by the engineer of record.

1. Non-requirement of submittals, when so noted, is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.

2. Any deviation from specified items is considered a substitution. If the contractor desires to use other than specified items, then a formal request for substitution must be submitted prior to bid date (no exceptions), in accordance with the procedures and time limitations set forth in Division 01. Where not defined in Division 01, requests for substitutions shall be submitted no less than ten (10) working days prior to bid date. Review of substitution requests by the

Engineer shall be done at the expense of the contractor. Charges for this substitution review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

B. It is the responsibility of the Contractor to ensure that all submittals have been reviewed for total completeness and accuracy as to the requirements of the specifications and drawings before being submitted to the Engineer for review.

1. One comprehensive submittal shall be provided for each individual specification section. All required submittal information called for in each individual specification section shall be included in the submittal.

2. The Engineer of Record shall not be responsible for informing the contractor on items that have not been included and are necessary for a complete review of the required submittal information for a specification section.

3. The Engineer of Record shall have the option of returning any submittal, unmarked, if all required documentation called for in the specifications has not been provided in the submittal.

4. The Engineer of Record shall review each submittal no more than two (2) times and return to the contractor with the appropriate disposition.

5. If the Engineer of Record is required to review a submittal a second time, it shall be limited to review of the changed information, clearly highlighted by the submitter, and/or confirmation of documentation only and it shall be returned to the contractor with the appropriate disposition.

6. If the submittal is required to be reviewed a third time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

C. Operation and Maintenance Manuals: All items required for insertion into each Operation and Maintenance (O&M) Manual are called out in the submittals portion of each specification section or in a Submittal Log, if included within Division 01. It is the responsibility of the Contractor to ensure that the O&M submittal has been reviewed and includes all the requirements of the specifications. The Engineer of Record shall review the submittal for the Operation and Maintenance Manual one (1) time and return to the contractor with the appropriate disposition.

1. If the submittal is required to be reviewed a second time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.

2. Submittals for the Operation and Maintenance Manual must be original documentation.

3. Photo copies of marked up Operations and Maintenance submittals are not acceptable.

D. Refer to Division 01 and each individual Division 22 Section for additional submittal requirements.

E. Prepare maintenance manuals in accordance with Division 01. In addition to the requirements specified in Division 01, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

5. Facsimiles or photo copies are not allowed as submittals for operating and maintenance manuals. Submittals for operating and maintenance manuals must be on original manufacturer printed stock.

F. Prepare and submit Coordination Drawings as further described herein. The Engineer shall receive one copy of all coordination drawings supplied to the Owner as required in this specification. It is the responsibility of the Contractor to coordinate the work as outlined herein. Receipt by the Engineer of a copy of the coordination drawings is to verify conformance to the submittal requirements set forth in this specification section. It is not an admission by the Engineer as to the accuracy or completeness of the coordination proposed.

G. Coordination shall be drawn to a scale of ¼" = 1'0" or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement. Include all piping including but not limited to Plumbing piping, HVAC piping, and fire protection piping. Include ceiling and wall-mounted access doors and panels required to provide access to valves and other operating devices.

2. Planned ductwork layout, including terminal units, dampers and specialty locations, with terminal unit and damper operator clearances. Include ceiling and wall-mounted access doors and panels required to provide access to dampers and other operating devices.

3. Clearances for installing and maintaining insulation.

4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.

5. Equipment and accessory service connections and support details.

6. Exterior wall and foundation penetrations.

7. Fire-rated wall and floor penetrations.

8. Sizes and location of required concrete pads and bases.

9. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.

10. Floor plans, elevations, and details to indicate penetrations in floors, walls, ceilings and roofs, and their relationship to other penetrations and installations.

11. Ceiling plans showing coordination of mechanical, electrical, structural, ceiling suspension assembly, lighting, security, communications, fire alarm, plumbing, and fire protection work within allotted space.

12. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, access panels, special moldings, and other ceiling-mounted items.

13. Floor plans and sections of fan rooms and mechanical rooms; show layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

H. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Indicate actual inverts and horizontal locations of all underground piping.

2. Valve location diagrams, complete with valve tag chart. Refer to Division 220500 Section “Basic Plumbing Materials and Methods.”

3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

5. Contract Modifications, actual equipment and materials installed.

6. Invert elevation of underfloor sanitary and storm piping.

I. Comply with each individual Division 22 Section for additional submittal requirements.

1.5 MATERIAL AND EQUIPMENT SELECTION

A. Product Options: The specification of each item of major mechanical equipment required for the project may include a list of manufacturers, with one “basis of design” manufacturer, type, and model identified by virtue of their listing in the equipment schedule on the Drawings. Where several manufacturers in addition to the “basis of design” manufacturer are listed in the specifications, it shall be understood that the words “or approved equal by” are implied to precede each of the other manufacturer’s names.

1. The manufacturers other than the “basis of design” may be furnished at the contractor’s option in lieu of the “basis of design” product, provided that the selected manufacturer’s product is equal in all material and functional respects. In addition to submittal requirements that may be specified in this section, submit a line-by-line written verification of the applicable specification section(s) identifying compliance with or variations from the specified features, materials, performance, capacities, weight, size, durability, energy consumption and efficiency, warranty, and visual impact (if exposed to view by other than maintenance persons). The burden of proof of manufacturer/product equality is on the contractor.

2. Where a product is not scheduled on the drawings and, therefore, where no “basis of design” is indicated, selection among all of the listed manufacturers and products is at the contractor’s option, subject to the requirements of the Contract Documents.

3. Products of manufacturers not listed in the Contract Documents are considered Substitutions

and are not permitted, except as provided under the General and Supplementary Conditions and Division 01 Specifications. Full compliance with Division 01 section “Product Substitutions” is mandatory for acceptance of products or manufacturers not listed.

B. Listing of a manufacturer does not imply approval of that manufacturer’s standard product or products. Rather, listing of a manufacturer indicates only a general acceptance of that manufacturer’s name and reputation. Final approval is subject to full compliance with these Contract Documents.

C. Model numbers identified on the Drawings notwithstanding, all equipment must comply with the requirements of these Contract Documents. Do not assume that a manufacturer’s standard product is acceptable as is. For example, one or more custom modifications, custom colors or finishes, manufacturer’s options, and/or accessories may be required to meet the specified requirements.

D. Where drawings indicate sizes, profiles, connections, and dimensional requirements of material and equipment, these are based on the “basis of design” manufacturer, type and model indicated. In the event that equipment of power, dimensions, capacities, layout, connections, and/or ratings differing from the “basis of design” are selected by the contractor and approved by the Owner’s representative, any necessary adjustments are the contractor’s responsibility. All connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, pipe and duct sizes, pipe and duct layout, and the like shall be adjusted by the contractor to suit the equipment provided. No additional costs will be approved for these changes. Should revisions to the design because of contractor’s selection of manufacturer, type, or model other than the “basis of design” require additional review and/or redesign by an Architect or Engineer, the contractor shall reimburse the Owner for Owner’s added professional fee expenses.

E. Where two or more materials are listed in the “Part 2 – Products” subsection of any Division 22 section, do not assume that the selection of materials is the contractor’s option. Refer to “Part 3 – Execution” subsection of that same Division 22 section for an explanation of which specific material(s) shall be used for which specific application(s). For example, Part 2 may list several types and grades of piping, and Part 3 will describe which type and grade of pipe to use for a given application.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Protect stored on-site or installed absorptive materials from moisture damage. Materials directly exposed to moisture via precipitation, water leaks, or condensation shall be removed from the jobsite and replaced.

END OF SECTION 220100

SECTION 22 05 00 – BASIC PLUMBING MATERIALS AND METHODS

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. Section 200800 “Seismic Protection” and Section 220100 “Basic Plumbing Requirements” apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes the following basic plumbing materials and methods to complement other Division 22 Sections:

1. Materials and installation instructions common to plumbing systems.
2. Pipe joining materials and methods.
3. Dielectric fittings.
4. Flexible pipe connectors.
5. Plumbing sleeve seals.
6. Pipe sleeves.
7. Escutcheons.
8. Penetration firestopping of fire-resistance-rated assemblies and/or smoke barriers by plumbing piping or conduit.
9. Labeling and identifying plumbing systems and equipment.
10. Non-shrink grout for equipment installations.
11. Painting and finishing of plumbing work.
12. Concrete base construction requirements.
13. Coordination with Structural work.

B. Pipe and pipe fitting materials are specified in individual Division 22 piping system Sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following abbreviations are used throughout Division 22 Specification Sections:

1. ABS: Acrylonitrile-butadiene-styrene plastic.

2. CPVC: Chlorinated polyvinyl chloride plastic.

3. CR: Chlorosulfonated polyethylene synthetic rubber.

4. EPDM: Ethylene propylene diene terpolymer rubber.

5. NBR: Acrylonitrile-butadiene rubber.

6. NP: Nylon plastic.

7. PE: Polyethylene plastic.

8. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For dielectric fittings, transition couplings, flexible pipe connectors, plumbing sleeve seals, and identification materials and devices.

B. For each type of penetration firestopping product, submit product data and include design designation of qualified testing and inspecting agency

C. Shop Drawings: Detail fabrication and installation for supports and anchorage for plumbing materials and equipment.

D. Coordination Drawings: For access panel and door locations.

1.5 QUALITY ASSURANCE

A. Welding: Qualify welding processes and operators for structural steel according to AWS D1.1 “Structural Welding Code – Steel.”

B. Welding: Qualify welding processes and operators for piping according to ASME “Boiler and Pressure Vessel Code,” Section IX, “Welding and Brazing Qualifications.”

1. Comply with provisions of ASME B31 Series “Code for Pressure Piping.”

2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

3. Contactor shall retain all welding certificates on file and produce them for review upon request by the Owner and/or Owner’s representative.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor or roof, if stored thereupon.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

E. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate plumbing equipment installation with other building components.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for plumbing installations.

C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

D. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate requirements for access panels and doors if plumbing items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section “Access Doors and Panels.”

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

H. Coordinate connection of electrical services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
Transition Couplings:

a. Dresser Industries, Inc.
b. or approved equal.

2. Dielectric Fittings:

a. Eclipse, Inc.; Rockford-Eclipse Div.
b. Grinnell Corp.; Grinnell Supply Sales Co.
c. Watts Industries, Inc.; Water Products Div.
d. Zurn Industries, Inc.; Wilkins Div.

3. Flexible Pipe Connectors:

a. Flexicraft Industries, Inc.
b. Hyspan Precision Products, Inc.
c. Mason Industries, Inc.
d. The Metraflex Company
e. Proco Products, Inc.

4. Plumbing Sleeve Seals:

a. Advanced Products and Systems, Inc./Innerlynx
b. The Metraflex Company
c. Thunderline/Link-Seal.

5. Identifying Devices and Labels:

a. Brady USA, Inc., Signmark Div.
b. Brimar Industries, Inc.
c. Kolbi Industries, Inc.
d. Panduit Corp.
e. Seton Name Plate Co.

2.2 PIPE AND PIPE FITTINGS

A. Refer to individual Division 22 piping Sections for pipe and fitting materials and joining methods.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for joining materials.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

C. Pipe-Flange Joining Gaskets: ASME B16.21, EPDM, flat, asbestos-free, 1/8-inch (3.2-mm) thickness, unless noted otherwise.

1. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

2. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

D. Pipe-Flange Joining Bolts and Nuts: ASME B18.2.1 bolts with ASME B18.2.2 nuts, carbon steel, unless otherwise indicated.

1. Bolts and nuts shall be Type 304 or Type 316 stainless steel, if installed on stainless steel piping, and matching the grade of stainless steel piping.

2. Bolts and nuts shall be Type 304 stainless steel if installed on uninsulated piping located outdoors.

3. Bolts and nuts shall be Type 316 stainless steel if installed on uninsulated direct-bury piping.

E. Solder Filler Metals: ASTM B32 lead-free alloys. Include water-flushable flux according to ASTM B813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements: Manufacturer's standard solvent cements for the following:

1. ABS Piping: ASTM D2235.

2. CPVC Piping: ASTM F493.

3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.

4. PVC to ABS Piping Transition: ASTM D3138.

I. Plastic Pipe Seals: ASTM F477, elastomeric gasket.

2.4 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

B. Description: Combination of copper alloy and ferrous, threaded, solder, plain, and weld-neck end types and matching piping system materials.

C. Insulating Material: Suitable for system fluid, pressure, and temperature.

D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180ºF (82 C).

E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225ºF (107ºC).

2.5 FLEXIBLE PIPE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide equipment-pipe connections.

B. Flexible Pipe Connectors for Copper Piping: Corrugated bronze inner tubing covered with interwoven bronze wire braid. Include copper-tube ends, brazed to hose.

C. Flexible Pipe Connectors for Steel Piping: Corrugated stainless steel inner tubing covered with interwoven stainless-steel wire braid.

D. Performance Rating Requirements:

1. Misalignment: Rated for ¾-inch (20-mm) permanent lateral offset.

2. Length: As needed to allow offset rating above, but not less than 9-inches (230 mm).

3. Design Working Pressure: 150 psig (1035 kPa) at 300°F (149°C).

E. Schedule of End Connections:

1. 2-Inch NPS (DN50) and Smaller, Copper Pipe: Copper tube end connections suitable for soldering to adjacent piping; except that brazed end connections are required for refrigerant service.

2. 2-Inch NPS (DN50) and Smaller, Steel Pipe: Threaded-end carbon steel nipples welded to hose; except that stainless-steel ends are required for natural gas service or where mated to stainless steel piping.

3. 2½-Inch NPS (DN65) and Larger: Carbon-steel flanged end connections welded to hose and drilled to meet ANSI Class 150; except that stainless-steel flanged end connections are required for natural gas service or where mated to stainless steel piping.

F. Flexible pipe connectors specified herein are for use at the piping connection to a piece of plumbing equipment, including but not limited to pumps. These are not acceptable for use where “expansion joints” or “pipe expansion fittings” are called out. Refer to Division 22 Section “Pipe Expansion Fittings” for pipe expansion joints or pipe expansion fittings.

2.6 MODULAR SLEEVE SEALS

A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Stainless steel. Include two for each sealing element.

D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

E. Minimum Temperature Rating: -40°F to +210°F (-40°C to +99°C).

2.7 PIPE SLEEVES

A. The following sleeve materials are for wall, floor, slab, and roof penetrations.

B. Steel Pipe: ASTM A53, Type E, Grade A, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated “wall pipe” equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

E. PE: Manufactured, reusable, tapered, cup shaped, smooth outer surface, with nailing flange for attaching to wooden forms.

F. Contractor’s Option: Pre-engineered, UL-listed fire-resistance rated and watertight cast-in-place floor sleeving systems meeting the following specifications will be acceptable in lieu of traditional floor sleeves with field-installed firestop, at contractor’s option.

1. Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in concrete floors formed with wood and/or steel decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, fire, and hot gasses.

2. Manufacturer: Subject to compliance with requirements, provide Hydroflame™ sleeving system by Hubbard Enterprises / Holdrite; or approved equal.

3. Include an outer sleeve lined with an intumescent strip; and a radial extended flange attached to one end of the sleeve for fastening to concrete formwork; or wide outside wings attached to one end of the sleeve for fastening to metal deck concrete formwork and span deck corrugations.

4. Include a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab. For applications involving a corrugated deck, also include a cone attached to the base for extending the device through the metal deck.

5. Product shall provide a two-hour fire-resistance rated assembly when tested according to ASTM E814 or ANSI/UL 1479.

2.8 ESCUTCHEONS

A. General: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Stamped-Steel Type: With spring clips and chrome-plated finish.

D. Split-Plate, Stamped-Steel Type: With concealed hinge, spring clips, and chrome-plated finish.

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

F. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 IDENTIFYING DEVICES AND LABELS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 22 Sections. If more than one type is specified for application, selection is installer's option, but provide one selection for each product category.

B. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

C. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment; furnished and factory-installed by original equipment manufacturer.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.

2. Location: Accessible and visible location.

D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, complying with ASME A13.1.

1. Nomenclature: Domestic Cold Water, Domestic Hot Water, Domestic Hot Water Return, Natural Gas, etc. as required per service. Match name to the name given on Drawings (full names, not abbreviations).

2. Color: Per ASME A13.1 Standard per service, unless noted otherwise.

3. Flow Direction: Indicate flow direction via arrows on each label.

E. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated.

1. Fabricate in sizes required for message.

2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.

3. Punch for mechanical fastening.

4. Thickness: 1/16-inch (1.6 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) long; 1/8-inch (3.2 mm) for larger units.

5. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.

F. Valve Tags: Photo-anodized barcode tags with ¼-inch (6-mm) letters and numbers. Include 5/32-inch (4-mm) hole for fastener.

1. Material: 0.032-inch (0.8-mm) thick anodized aluminum.

2. Color: Silver background with black characters.

3. Printed Nomenclature: Piping system abbreviation and sequenced number; e.g., HW-23 for domestic hot water supply valve #23; HWR-12 for domestic hot water return valve #12.

4. Barcode: Two-dimensional Data Matrix ECC 200 barcode symbology. Prior to manufacture, obtain valve tag information from owner's property manager for encoding into the barcode. Include valve number, piping system, system abbreviation, location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

G. Valve Tag Fasteners: Brass, wire-link chain or stainless steel beaded chain.

H. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in plumbing identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of plumbing systems and equipment.

1. Multiple Systems: If multiple systems of same generic name are indicated, provide identification that indicates individual system number and service such as "Domestic Water Heater DWH1," "Hot Water Recirculation Pump HWRP1," or "Standpipe F12."

2.10 CONCRETE AND GROUT

A. Concrete: For all minor concrete work required for plumbing installations, such as concrete equipment bases and supports, refer to Division 03 Sections for specification of cast-in-place concrete and reinforcing materials, whose requirements apply to the work of Division 22 as if fully reproduced herein.

B. Concrete: For all minor concrete work required for plumbing installations, such as concrete equipment bases and supports, provide Quikrete® Commercial Grade FastSet™ Concrete #1004-51 prepackaged concrete mix, or approved equal. Mix, place, and cure in accordance with manufacturer's written instructions.

1. Reinforcing: ASTM A615 Grade 60 deformed bars and ASTM A185 welded wire fabric.

C. Non-shrink, Nonmetallic Grout: ASTM C1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psig (34.5-MPa), 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 GENERAL PLUMBING INSTALLATION REQUIREMENTS

A. Verify all dimensions by field measurements.

B. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

C. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

D. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

E. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

F. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.2 PIPE-PENETRATION INSTALLATION REQUIREMENTS

A. Install escutcheons for new piping penetrations of walls, ceilings, and floors according to the following:

1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

2. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

3. Insulated Piping: One-piece, stamped-steel type with spring clips.

4. Uninsulated Piping in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

5. Uninsulated Piping in Unfinished Spaces: One-piece, cast-brass type.

6. Uninsulated Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

B. Install escutcheons for existing piping penetrations of new walls, ceilings, and floors. Match type, material, and finish as specified for new piping, except that split-casting or split-plate type will be accepted in lieu of one-piece.

C. Install sleeves for pipes passing through concrete and masonry walls, and concrete floor and roof slabs.

D. Cut sleeves to length for mounting flush with both surfaces. Exception: Extend sleeves installed in floors of mechanical/plumbing equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

E. Fire-Resistance Rated, Cast-in-Place Sleeve Installation: Select sleeve size based on size and

type of pipe and thickness of the floor. Position and secure sleeve to concrete form using nails or staples. Place concrete, and finish even with top of sleeve. Install in complete and strict accordance with manufacturer's UL-listed installation instructions.

F. Build sleeves into new walls and slabs as work progresses.

G. Install sleeves large enough to provide ¼-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

1. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS (DN150).

2. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Flashing and Sheet Metal" for flashing.

3. Seal space outside of sleeve fittings with non-shrink, nonmetallic grout.

H. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division 07 Section "Joint Sealants" for materials. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.

I. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) in diameter and larger.

3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.

J. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

3.3 EQUIPMENT INSTALLATION REQUIREMENTS

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Division 22 and Division 26 for rough-in requirements.

C. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

D. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.

E. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

F. Positive attachment and anchorage of all equipment to the structure or floor is required. Do not rely on friction or gravity as a means of attachment.

G. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

H. Install equipment giving right of way to piping installed at required slope.

I. Install flexible pipe connectors at the following locations. Install on equipment side of shutoff valves.

1. Inlet and outlet of each pump.

2. Where indicated elsewhere in these specifications.

3. Where detailed on the Drawings.

J. Support for Suspended Equipment: As specified in Division 22 Section “Hangers and Supports.”

3.4 LABELING AND IDENTIFYING

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow. Use plastic markers, with application systems. Install on insulation segment if required for hot, uninsulated piping.

B. Locate pipe markers as follows if piping is exposed in finished spaces, machine rooms, and accessible maintenance spaces, such as shafts, tunnels, plenums, and exterior non-concealed locations:

1. Near each valve and control device.

2. Near each branch, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, if flow pattern is not obvious.

3. Near locations where pipes pass through walls, floors, ceilings, or enter non-accessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum of 50-foot (15-m) intervals along each run. Reduce intervals to 25 feet (7.5 m) in congested areas of piping and equipment.

7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

C. Install continuous plastic underground warning tapes during back filling of trenches for underground piping. Locate 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping. Refer to Division 31 Section “Earth Moving” for warning-tape materials and devices and their installation.

D. Equipment: Install engraved plastic-laminate sign on or near each major item of plumbing equipment.

1. Lettering Size: Minimum ¼-inch- (6.4-mm-) high lettering for name of unit if viewing distance is less than 24 inches (610 mm), ½-inch- (12.7-mm-) high lettering for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.

2. Text of Signs: Provide name of identified unit. Include text to distinguish between multiple units,

inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

E. Adjusting: Relocate identifying devices as necessary for unobstructed view in finished construction.

F. Install valve tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, faucets, and similar roughing-in connections of end-use fixtures and units.

3.5 PAINTING AND FINISHING

A. For all painting and finishing work required for plumbing installations, refer to Division 09 Sections for application requirements.

B. Painting Plumbing Work: Paint the following work where exposed to view in finished or unfinished spaces: Uninsulated steel piping, pipe hangers and supports, tanks that do not have factory-applied final finishes, all interior and exterior ferrous piping and appurtenances, including steel, galvanized steel, cast iron and ductile iron.

C. In addition, paint the following:

1. Equipment, and pipe insulation having ASJ or other paintable jacket material.

D. Steel Substrates: Primer, alkyd, anti-corrosive, for metal, MPI #79; plus topcoat of latex, interior, semi-gloss, MPI #54.

E. Galvanized-Metal Substrates: Primer, galvanized, water based, MPI #134; plus topcoat of latex, interior, semi-gloss, MPI #54.

F. Aluminum (Not Anodized or Otherwise Coated) Substrates: Primer, quick dry, for aluminum, MPI #95; plus topcoat of latex, interior, semi-gloss, MPI #54.

G. ASJ Insulation-Covering Substrates: Including pipe and duct coverings. Primer sealer, latex, interior, MPI #50; plus topcoat of latex, interior, semi-gloss, MPI #54.

H. Primers specified above may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

3.6 CONCRETE BASES

A. Anchor equipment to concrete base according to equipment manufacturer’s written instructions and according to Division 20 Section “Seismic Protection.”

B. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.

C. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.

D. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

E. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

F. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

H. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03.

3.7 COORDINATION WITH STRUCTURAL WORK

A. Concrete: Do not embed pipes, wires, tube, boxes, ducts or other cavity-creating elements in concrete work unless shown on or permitted by the structural drawings. Openings through concrete not shown on the structural drawings are subject to approval by the structural engineer of record. See coordination drawing requirements under Submittals.

B. Roof Deck: Do not place loads on, or hang any loads whatsoever from roof deck, unless shown on structural drawings, including, but not limited to, hangers for pipes, ducts, equipment, etc. Trade contractor installing such loads shall provide sub-framing connected to steel frame.

1. Do not exceed capacity of roof deck as a working platform. Submit all proposed construction loads to deck supplier for approval.

2. Openings in roof deck not shown on structural drawings, such as openings required for stacks, pipes, ducts, plumbing vents, etc., shall be cut and reinforced by trade requiring opening.

C. Supported Slab: Do not suspend loads exceeding 500 pounds within any 100 square feet of contiguous area from concrete supported slab. Suspend such loads from structural steel only. Any "sub-framing" required is responsibility of Contractor or sub-contractor installing material requiring support.

1. Openings in concrete floor slabs not shown on structural drawings, such as openings required for stacks, pipes, ducts, plumbing vents, etc., shall be the responsibility of the trade requiring openings. Form block-outs in the slab, reinforcing deck, and cut openings after concrete has reached specified strength.

2. Where openings larger than 12-inches are required but not shown on structural drawings, secure written approval from Architect/Engineer prior to cutting deck.

3.8 ERECTION OF SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

B. Field Welding: Comply with AWS D1.1, "Structural Welding Code – Steel."

3.9 GROUTING

A. Install nonmetallic, non-shrink, grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Mix grout according to manufacturer's written instructions. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Place grout, completely filling equipment bases. Avoid air entrapment during placing of grout. Place

grout on concrete bases to provide smooth bearing surface for equipment. Place grout around anchors.

E. Cure placed grout according to manufacturer's written instructions.

END OF SECTION 220500

SECTION 22 05 23 – VALVES

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. Section 200800 “Seismic Protection,” Section 220100 “Basic Plumbing Requirements,” and Section 220500 “Basic Plumbing Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes the following general-duty valves common to Division 22 plumbing piping systems:

1. Ball valves.

2. Butterfly valves.

3. Check valves.

B. Related Sections include the following:

1. Division 22 piping Sections for general-duty and specialty valves for site construction piping.

2. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.

3. Division 22 Section “Plumbing Identification” for valve tags and charts.

4. Division 22 Section “Basic Plumbing Materials and Methods” for valve tags and charts.

5. Division 22 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves used in this Section:

1. CWP: Cold working pressure (formerly WOG – Water, Oil, Gas working pressure).

2. EPDM: Ethylene-propylene-diene terpolymer rubber.

3. IBBM: Iron body, bronze-mounted.

4. PTFE: Polytetrafluoroethylene plastic.

5. SWP: Steam working pressure.

6. TFE: Tetrafluoroethylene plastic.

7. Class 125: Minimum 125-psig (860-kPa) SWP and minimum 200-psig (1380-kPa) CWP ratings.

8. Class 150: Minimum 150-psig (1035-kPa) SWP and minimum 300-psig (2070-kPa) CWP ratings.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

B. Maintenance Data: For each type of valve, to include in the operation and maintenance manual specified in Division 01. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.5 QUALITY ASSURANCE

C. ASME Compliance: ASME B31.9 for building services piping valves.

D. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

E. NSF Compliance: NSF 61 for valve materials for potable-water service in compliance with Public Law #111-380.

F. MSS Compliance: Comply with the various MSS Standard Practice documents referenced herein.

1.6 DELIVERY, STORAGE, AND HANDLING

G. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set ball valves open to minimize exposure of functional surfaces.

4. Set butterfly valves closed or slightly open.

5. Block check valves in either closed or open position.

H. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

I. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General: Subject to compliance with requirements, provide gate valves, globe valves, and swing check valves by one of the following:

1. Apollo.

2. Hammond Valve.

3. Milwaukee Valve Company.

4. NIBCO Inc.

5. Watts Industries, Inc.; Water Products Div.

B. Ball Valves: Subject to compliance with requirements, provide ball valves by one of the following:

1. Any of the manufacturers listed under the “General” subheading above.

C. Standard-Performance Butterfly Valves: Subject to compliance with requirements, provide butterfly valves by one of the following:

1. Any of the manufacturers listed under the “General” subheading above.

D. Swing, piston and Wafer Check Valves: Subject to compliance with requirements, provide butterfly-style dual-plate wafer check valves, piston-style lift-disc, and swing check valves by one of the following:

1. Any of the manufacturers listed under the “General” subheading above.

2.2 VALVES, COMMON REQUIREMENTS

A. General: Refer to Part 3 “Valve Applications Schedule” Article for application schedule of valves, end connections, and actuator types.

B. Valve Sizes: Same as upstream pipe size, unless otherwise indicated.

C. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

D. Valve Grooved Ends: AWWA C606.

E. Valve Threaded Ends: With threads according to ASME B1.20.1.

F. Valve Bypass and Drain Connections: MSS SP-45.

G. Material Substitution: Ductile iron is acceptable anywhere cast iron is specified, but cast iron is not acceptable where ductile iron is specified.

H. Class Substitution: If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

I. For piping systems required to be insulated, valve stems shall be extended to accommodate insulation. Refer to other Division 22 Sections for piping systems required to be insulated.

K. NSF Compliance: NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

L. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

M. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

2.3 BALL VALVES

A. Liquid Service, Size NPS 2-1/2 and smaller:

1. Full Port Valves

2. Minimum CWP rating: 600-psig.

3. Body: ASTM B584 bronze, two-piece construction.

4. Ball: Type 316 stainless steel, full port.

5. Stem: Blowout-proof Type 316 stainless steel.

6. Seat/Packing: TFE.

7. Ends: Threaded/Soldered.

8. Handle: Vinyl-covered steel lever with memory stop; and zinc-plated steel nut.

9. Apollo 77-240, Watts B-6801, Hammond 8511 or approved equal.

2.4 STANDARD-PERFORMANCE BUTTERFLY VALVES

A. General: Valve shall conform to MSS SP-67, Type I.

B. Minimum CWP rating: 175-psig (1207-kPa).

C. Body and bonnet: ASTM A536 ductile-iron, extended neck. Cast iron valves will be rejected.

D. Packing: Field-replaceable EPDM sleeve and stem seals.

E. Stem and Stem Hardware: Type 316 or 416 stainless steel.

F. Disc: Aluminum bronze or Type 316 stainless steel.

G. End Connections: Lug and flanged bodies are acceptable; wafer bodies are not acceptable. Grooved-end valve bodies are acceptable wherever grooved-end piping is permitted; refer to other Division 22 Sections for permitted applications of grooved-end piping.

H. Dead End Service: All butterfly valves shall be suitable for bi-directional dead-end service without downstream blind flange. Bolt holes on lugged valve bodies shall be threaded per ANSI B-1.1 coarse thread, with center stop, to accept cap screws from both directions.

I. Operator: Lever handle with ten-position latching mechanism.

J. Approved Manufacturers and Models: Nibco LD2000, Milwaukee ML-133E, Hammond 6411, Bray 31H, Apollo LD-145, Watts DBF-03

2.5 CHECK VALVES

A. Check valves installed at pump discharge size 2-1/2" and larger shall be silent type, 2" and smaller may be swing type.

B. Bronze Swing Check Valve, NPS 2 (DN50) and smaller: Valve shall conform to MSS SP-80.

1. Minimum pressure rating: Class 150.

2. Body: ASTM B62 bronze body, y-pattern.

3. Bonnet: ASTM B62 bronze, threaded, removable for regrinding.

4. Disc and seat: Renewable; ASTM B62 bronze with bronze-alloy hinge pin.

5. Hardware: Bronze or bronze alloy.

6. Ends: Threaded.

C. Silent Check Valves, NPS 2½ (DN65) and larger: Valve.

1. Minimum pressure rating: Class 125 (200 PSI at 150F).

2. Body: ASTM A126 Cl. B cast-iron body and bronze-mounted (IBBM).

3. Bonnet: ASTM A126 Cl. B cast-iron, bolted to body with steel bolts.

4. Disc and seat: Renewable; Ductile-iron or bronze-alloy.

5. Ends: Flanged.

6. Nibco F-910, Grinnell Series 500, Milwaukee 125 Class, Mueller 91-AP, or approved equivalent.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves as indicated, according to manufacturer's written instructions.

B. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install isolation valves at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

D. Locate valves for easy access and provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above center of pipe.

F. Any valve that represents a termination or the end of a run (e.g., blowdown or drain valve, hose-end valve, etc.) shall be fitted with a permanent but removable cap, plug, or blind flange matching the valve construction, to minimize risk in the event the valve is accidentally opened under pressure.

G. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level, or vertical with upward flow.

3.3 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Threaded Connections: Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

1. Align threads at point of assembly.

2. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

3. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

D. Flanged Connections: Align flange surfaces parallel.

1. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

2. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.4 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.5 VALVE APPLICATIONS SCHEDULE

A. General: Refer to piping Sections and Drawings for specific valve applications. If no specific valve type is indicated, use the valve types indicated in the following schedules.

B. Domestic Water Piping: Choices are contractor's option unless a specific type of valve is specifically called out by name on the Drawings.

1. For shutoff duty, NPS 2 (DN 50) and smaller, use ball valves.

2. For shutoff duty, NPS 2½ (DN 65) and larger, use butterfly valves.

3. For pump discharge protection, NPS 2 (DN 50) and smaller, use swing check valves.

4. For Pump discharge protection NPS 2-1/2" and larger use silent check valve.

5. For one-way flow control other than at pump discharge, use swing check valves in all sizes.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal hanger-shield inserts.
4. Fastener systems.
5. Pipe-positioning systems.
6. Equipment supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations.

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

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Pipe Welding Qualifications: Qualify procedures and operators according to "2015 ASME Boiler and Pressure Vessel Code, Section IX."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL HANGER-SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Anvil International.
2. B-Line Systems.
3. ERICO/Michigan Hanger Co.
4. National Pipe Hanger Corporation.
5. PHD Manufacturing.
6. Tolco.

B. Insulation-Insert Material for Cold Piping: ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psig ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ACS Industries.
    b. GEMCO.
    c. Hilti, Inc.
    d. Midwest Fasteners.

2. Indoor Applications: Zinc-coated or stainless steel.
3. Outdoor Applications: Stainless steel.

2.6 PIPE-POSITIONING SYSTEMS

A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.8 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating Below Ambient Air Temperature and Above 165F: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal hanger-shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system 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.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 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 percent to allow 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 percent to allow 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 percent to allow 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 one trapeze member.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Us mechanical-expansion anchors instead of building attachments where required in concrete construction.

Q. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

1.2 ACTION SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Brady Corporation.
    b. Carlton Industries, LP.
    c. Champion America.
    d. Craftmark Pipe Markers.
    e. Kolbi Pipe Marker Co.
    f. LEM Products Inc.
    g. Marking Services Inc.
    h. Pipemarker.com; Brimar Industries, Inc.
    i. Seton Identification Products; a Brady Corporation company.
    j. emedco.
2. Material and Thickness: anodized aluminum, 0.032-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for

greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Brady Corporation.
    b. Carlton Industries, LP.
    c. Champion America.
    d. Craftmark Pipe Markers.
    e. Kolbi Pipe Marker Co.
    f. LEM Products Inc.
    g. Marking Services Inc.
    h. Pipemarker.com; Brimar Industries, Inc.
    i. Seton Identification Products; a Brady Corporation company.
    j. emedco.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.
4. Craftmark Pipe Markers.
5. LEM Products Inc.
6. Marking Services Inc.
7. National Marker Company.
8. Pipemarker.com; Brimar Industries, Inc.
9. Seton Identification Products; a Brady Corporation company.
10. Stranco, Inc.

11. emedco.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.
4. Craftmark Pipe Markers.
5. LEM Products Inc.
6. Marking Services Inc.
7. National Marker Company.
8. Pipemarker.com; Brimar Industries, Inc.
9. Seton Identification Products; a Brady Corporation company.
10. Stranco, Inc.
11. emedco.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Sign and Label Colors.

1. White letters on an ANSI Z535.1 safety-green background

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where are-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E[, and other applicable codes and standards.

3.4 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 20 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

D. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe-Label Color Schedule:

1. Low-Pressure Compressed-Air Piping: White letters on an ANSI Z535.1 safety-blue background.
2. High-Pressure Compressed-Air Piping: White letters on an ANSI Z535.1 safety-blue background.
3. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
4. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background
5. Domestic Hot-Water Return Piping White letters on an ANSI Z535.1 safety-green background.
6. Sanitary Waste Piping: White letters on a black background.

END OF SECTION 220553

SECTION 22 07 00 -PLUMBING PIPE 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.

B. Section 20 0800 “Seismic Protection,” Section 22 01 00 “Basic Plumbing Requirements,” and Section 22 0500 “Basic Plumbing Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes plumbing insulation for, equipment, piping, and other installations, including the following:

1. Insulation Materials:

    a. Flexible elastomeric.
    b. Mineral fiber.

2. Adhesives.

3. Sealants.

4. Field-applied jackets.

5. Tapes.

6. Securements.

7. Protective shielding guards.

B. Related Sections include the following:

1.3 DEFINITIONS

A. ASJ: All-service jacket.

B. FSK: Foil, scrim, kraft paper.

C. SSL: Self-sealing lap.

D. Thermal Resistivity: “R-values” represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1-inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one BTU to flow through one square foot of material, in one hour, at a given mean temperature.

E. Refer to Division 22 Section “Basic Plumbing Materials and Methods” for definitions of finished, interior, exterior, exposed, and concealed locations.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as determined by testing identical products per ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section “Hangers and Supports.”

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Flexible Elastomeric Insulation:

    a. Aeroflex USA Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.
    c. K-Flex USA; Insul-Lock® Seam-Seal.
    d. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

2. Mineral-Fiber, Preformed Pipe Insulation:

    a. Johns Manville.
    b. Knauf Insulation.
    c. Manson Insulation Inc.
    d. Owens Corning.

3. Sealants, Adhesives and Mastics: Same as insulation manufacturer, or

    a. Childers Products, Division of ITW.
    b. Foster Products Corporation, H. B. Fuller Company.
    c. ITW TACC, Division of Illinois Tool Works.
    d. Marathon Industries, Inc.
    e. Mon-Eco Industries, Inc.
    f. Vimasco Corporation.

4. Field-Applied Jackets: Same as insulation manufacturer, or

    a. Childers Products, Division of ITW.
    b. P.I.C. Plastics, Inc.
    c. PABCO Metals Corporation.
    d. Pittsburgh Corning Corporation.
    e. Polyguard.
    f. Proto PVC Corporation.
    g. RPR Products, Inc.
    h. Speedline Corporation.

5. Tapes: Same as insulation manufacturer, or

    a. Avery Dennison Corporation, Specialty Tapes Division.
    b. Compac Corp.
    c. Ideal Tape Co., Inc., an American Biltrite Company.
    d. Venture Tape.

6. Insulation Pins and Hangers: Same as insulation manufacturer, or

    a. AGM Industries, Inc.
    b. GEMCO.
    c. Midwest Fasteners, Inc.
    d. Nelson Stud Welding.

2.2 INSULATION MATERIALS

A. Refer to Schedule in Part 3 for requirements about where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Adhesives shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials and Type II for sheet materials.

1. Thermal Conductivity: 0.27 average maximum at 100ºF mean temperature.

2. Adhesive: Comply with MIL-A-24179A, Type II, Class I.

3. Low-emitting (VOC) adhesive.

2.3 SEALANTS

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Permanently flexible, elastomeric sealant.

3. Service Temperature Range: Minus 100 to plus 300ºF (Minus 73 to plus 149 C).

4. Color: White or gray.

2.4 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: Compatible with PVC, as recommended by jacket material manufacturer.

2. Color: White.

3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

4. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

2.5 TAPES

A. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Width: 2-inches (50 mm).

2. Thickness: 6 mils (0.15 mm).

3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.

4. Elongation: 500 percent.

5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

2.6 SECUREMENTS

A. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1½-inch (38-mm) galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Baseplate shall be perforated, galvanized carbon-steel sheet, 0.030-inch (0.76 mm) thick by 2-inches (50 mm) square. Spindle shall be copper, aluminum, or stainless steel, fully annealed, 0.106-inch (2.6-mm) diameter shank, length to suit depth of insulation indicated. Adhesive shall be as recommended by hanger manufacturer; with demonstrated capability to bond insulation

hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Self-Sticking-Base Insulation Hangers: Adhesive-backed base with a peel-off protective cover; and baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Baseplate shall be galvanized carbon-steel sheet, 0.030-inch (0.76 mm) thick by 2-inches (50 mm) square. Spindle shall be copper, aluminum, or stainless steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41-mm) thick, aluminum or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1½-inches (38 mm) in diameter. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

2.7 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers.

1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain plumbing. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 COMMON INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4-inches (100 mm) o.c.

3. Overlap jacket longitudinal seams at least 1½-inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2-inches (50 mm) o.c.

4. For below ambient services, apply vapor-barrier mastic over staples.

5. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4-inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2-inches (50 mm) below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2-inches (50 mm).

4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations:

1. Install pipe insulation continuously through pipe penetrations of fire-rated walls and partitions.

2. Firestopping and fire-resistive joint sealers are specified in Division 07 Section “Penetration Firestopping.”

E. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

2. Seal penetrations through fire-rated assemblies according to Division 07 Section “Penetration Firestopping.”

3.5 PIPE INSULATION INSTALLATION

A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. If furnished in half sections, orient longitudinal joints at 3 and 9 o'clock positions on the pipe.

2. All insulation shall be tightly butted and free of voids and gaps at all joints.

3. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

4. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6-inches (150 mm) o.c.

5. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant. Vapor barrier must be continuous.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation, not to exceed 1½-inch (38-mm) thickness.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same thickness as pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1-inch (25 mm), and seal joints with flashing sealant.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when

available. Secure according to manufacturer's written instructions.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

3. Cut sectional pipe insulation to fit. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

E. Insulation Installation on Valves, Strainers, Unions, and Specials:

1. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation over valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

4. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below- ambient services, provide a design that maintains vapor barrier.

5. Insulate unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

7. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

8. Stencil or label the outside insulation jacket of each union with the word “UNION.” Match size and color of pipe labels.

F. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

G. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same

thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2-inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

H. Special Requirements for Flexible Elastomeric Insulation Installation: Seal all transverse seams, longitudinal seams, end joints, and section joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12-inches (300 mm) o.c. and at end joints.

3.7 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.8 PIPING INSULATION SCHEDULE, GENERAL

A. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Fire-suppression piping.

2. Drainage (sanitary/waste) piping

B. Hot Surfaces: For piping services denoted all piping surfaces including but not limited to pipe, flanges, fittings, valves of every kind, strainers, unions, and other appurtenances shall be

insulated to avoid potential for personnel injury via contact with hot surface.

C. Cold Surfaces: For piping surfaces operating below surrounding ambient temperature, all piping surfaces including but not limited to pipe, flanges, fittings, valves of every kind, strainers, unions, and other appurtenances shall be insulated and shall include uninterrupted vapor barrier to avoid potential condensation.

3.9 PIPE INSULATION SCHEDULE, INDOORS

A. Domestic Cold Water:

1. Insulation shall be any of the following:

a. Flexible Elastomeric: 1-inch (25 mm) thick.

B. Domestic Hot-Water Supply and Return, 140ºF and below:

1. NPS 1¼ and Smaller: Insulation shall be Flexible Elastomeric, 1-inch thick.

2. NPS 1½ (DN 40) and Larger: Insulation shall be Flexible Elastomeric, 1-1/2 inches thick.

C. Domestic Water Branch Piping to Fixtures within Walls/Chases (Hot and Cold; Non-Recirculated):

1. NPS 2 and smaller: Insulation shall be flexible elastomeric, 1/2 inch thick.

D. Storm Piping (including drain body and overflow storm piping)

1. NPS-ALL: Insulation shall be flexible elastomeric, 1” thick.

E. Sanitary (Lavatory P-Trap)

1. Provide ADA Insulation Kit for all lavatory drains.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over all mineral-fiber or fiberglass insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Except as noted below, apply the following field jackets on all mineral-fiber or fiberglass insulation:

1. Equipment: Aluminum, Stucco Embossed, 0.016-inch (0.41 mm) thick.

2. Piping: PVC, 30 mils (0.8 mm) thick.

C. Exceptions: Field jackets are not required over insulation in the following cases:

1. If equipment, piping, are concealed above a ceiling or in an enclosed shaft, chase or walls.

2. If equipment, piping, are installed 96-inches or greater above floor.

3. If equipment, piping, handle a service with a normal operating temperature 60°F (16°C) or higher. Except when exposed to view less than 96” above floor.

END OF SECTION 220700

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 200800 “Seismic Protection,” Section 220100 “Basic Plumbing Requirements,” and Section 220500 “Basic Plumbing Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. Section Includes:

1. Copper tube and fittings.

2. Piping joining materials.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than fourteen days in advance of proposed interruption of water service.

2. Do not interrupt water service without Owner’s written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

C. Comply with NSF Standard 372 for low lead.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions:

1. MSS SP-123.

2. Cast-copper-alloy, hexagonal-stock body.

3. Ball-and-socket, metal-to-metal seating surfaces.

4. Solder-joint or threaded ends.

F. Copper-Tube, Extruded-Tee Connections:

1. Description: Tee formed in copper tube according to ASTM F 2014.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.

2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install domestic water piping level without pitch and plumb.

C. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 200800 "Seismic Protection."

D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

E. 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.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

G. Install piping to permit valve servicing.

H. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

L. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."

M. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages."

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 “Basic Plumbing Materials and Methods."

O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 “Basic Plumbing Materials and Methods." Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 “Basic Plumbing Materials and Methods."

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before

assembly.

C. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

D. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.4 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220500 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.

2. Open shutoff valves to fully open position.

3. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

   a. Adjust calibrated balancing valves to flows indicated.

4. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

5. Remove and clean strainer screens. Close drain valves and replace drain plugs.

6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

7. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.7 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of

chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.8 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Aboveground domestic water piping, NPS 3 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.

3.9 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.

2. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.

3. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 20 0800 “Seismic Protection,” Section 22 0100 “Basic Plumbing Requirements,” and Section 22 0500 “Basic Plumbing Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. Section Includes:

1. Vacuum breakers.

2. Backflow preventers.

3. Balancing valves.

4. Temperature-actuated, water mixing valves.

5. Strainers.

6. Outlet boxes.

7. Hose bibbs.

8. Wall hydrants.

9. Drain valves.

10. Water-hammer arresters.

11. Specialty valves.

12. Flexible connectors.

13. Water meters.

B. Related Requirements:

1. Section 220519 "Meters and Gages" for thermometers, pressure gages, and flow meters in domestic water piping.

2. Section 221116 "Domestic Water Piping" for water meters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.

2. Body: Bronze, nonremovable, with manual drain.

3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.

4. Finish: For finished areas provide Chrome or nickel plated, and for unfished areas provide Rough bronze.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Acceptable manufacturers: WATTS 909 or Wilkins 375/375A

2. Standard: ASSE 1013.

3. Operation: Continuous-pressure applications.

4. Pressure Loss: 12 psig maximum, through middle third of flow range.

5. Size: See drawings.

6. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.

7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

8. Configuration: Designed for horizontal, straight-through flow.

9. Accessories:

    a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.

2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.

3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch.
    b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch.

6. Drain: Factory-installed, hose-end drain valve.

2.6 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.

2. Pressure Rating: 400-psig minimum CWP.

3. Size: NPS 3/4.

4. Body: Copper alloy.

5. Ball: Chrome-plated brass.

6. Seats and Seals: Replaceable.

7. Handle: Vinyl-covered steel.

8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.7 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Acceptable manufacturers: PPP Inc., WATTS, Sioux Chief.

2. Standard: ASSE 1010 or PDI-WH 201.

3. Type: Copper tube with piston.

4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.8 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.

2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.

3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.

2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.

3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.9 WATER METERS

A. Electromagnetic-Type Water Meters:

1. Acceptable manufacturers: Neptune HP Turbine, Kent T-3000, Heresey MTX

B. Water meter 1 ¼” and larger shall be a totalizing magnetic turbine meter indicating in U.S. Gallons meeting AWWA Standard C-701 latest edition. Meters shall be in-line horizontal-axis type per AWWA Class II, flanged cast bronze body, turbine measuring chamber, stainless steel spindle, and graphite bearings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.

3. Do not install bypass piping around backflow preventers.

B. Install pressure gages on inlet and outlet of water regulator.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Install Y-pattern strainers for water on supply side of each pump.

F. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

G. Install water-hammer arresters in water piping according to PDI-WH 201.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Coordinate list below with products retained in Part 2.

2. Reduced-pressure-principle backflow preventers.

3. Double-check, backflow-prevention assemblies.

4. Primary, thermostatic, water mixing valves.

5. Manifold, thermostatic, water mixing-valve assemblies.

6. Primary water tempering valves.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each reduced-pressure-principle backflow preventer and double-check, backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 221119

SECTION 221123.13 - DOMESTIC-WATER PACKAGED BOOSTER 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.

B. Section 20 0800 “Seismic Protection,” Section 22 0100 “Basic Plumbing Requirements,” and Section 22 0500 “Basic Plumbing Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 QUALITY ASSURANCE

A. Quality Standards for Packaged Booster Pumps: UL 508, UL 508A, UL 778, and UL 1995.

B. Drinking Water System Components: NSF 61 and NSF 372.

C. Booster pumps listed and labeled as packaged pumping systems.

1.3 MANUFACTURED UNITS

A. Triplex, Variable-Speed Booster Pumps:

1. Pump Type: Multistage vertical centrifugal pump.
2. Casing: Stainless Steel.
3. Impeller: Stainless Steel.
4. Shaft and Shaft Sleeve: Stainless Steel
5. Seal: Viton or Teflon
6. Orientation: Vertical
7. Motor: Variable speed.
8. Piping: Stainless Steel
9. Control Logic: Pressure control software with integral auto-tuning
10. Enclosure: NEMA 250, Type 3R
11. Starting Devices: Variable Frequency Drive
12. Instrumentation: Suction and discharge pressure monitors and gauges.
13. 44 gallon surge Suppression Tank
14. Building Automation System Interface: Auxiliary contacts for BACnet Include on-off status of pump and alarm status.
15. Base: Structural steel.

B. See Schedule for Design conditions and electrical requirements.

Approved Manufacturers: Quantumflo WhisperQuiet or Tigerflow Approved Equal.

END OF SECTION 221123.13

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 200800 “Seismic Protection,” Section 220100 “Basic Plumbing Requirements,” and Section 220500 “Basic Plumbing Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.

2. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than two weeks in advance of proposed interruption of sanitary waste service.

2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 CAST IRON SOIL PIPE NO-HUB

A. No hub soil pipe shall be in accordance with ASTM A-888 CISPI 301available with coal tar coating. 5ft and 10ft lengths, range 1-1/2” – 10”

B. Cast iron no hub pipe and fittings.

C. Pressure: Gravity Vented

D. Temperature: 140 degrees.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.

1. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 200800 “Seismic Protection”. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.

2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.

4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of waste piping in direction of flow is prohibited.

K. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

L. Install aboveground copper tubing according to CDA’s “Copper Tube Handbook.”

M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

N. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 “Basic Plumbing Material and Methods."

O. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 “Basic Plumbing Material and Methods."

2. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3. Comply with requirements for escutcheons specified in Section 220500 “Basic Plumbing Material and Methods."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
6. Equipment: Connect waste piping as indicated.
    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.3 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220500 "Basic Plumbing Materials and Methods"

3.4 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.5 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.6 PIPING SCHEDULE

A. Aboveground, soil, waste, and vent piping NPS 8 and smaller shall be the following:

1. Cast-Iron soil pipe, no hub with stainless steel coupling assembly with neoprene rubber gasket.

END OF SECTION 221316

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 200800 “Seismic Protection,” Section 220100 “Basic Plumbing Requirements,” and Section 220500 “Basic Plumbing Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.

2. Roof flashing assemblies.

3. Through-penetration firestop assemblies.

4. Miscellaneous sanitary drainage piping specialties.

5. Floor drains.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

2.2 CLEANOUTS

A. Cleanout: interior finished floor (FCO):

Cast iron body, threaded adjustable housing, flanged ferrule with straight thread gasketed plug and square secured satin nickel bronze scoriated top, vandal proof, tops shall be for tile, carpet, ceramic tile, terrazzo tile as required. Wade W-6000-TS-179-118, Zurn Z-1400-T-BP-VP, J.R. Smith 4052-U, MIFAB C1100-S-1-6, or approved equivalent.

B. Cleanout: interior unfinished floor (FCO):

Cast iron body, threaded adjustable housing, flanged ferrule with straight thread gasketed plug and round secured satin nickel bronze scoriated top, vandal proof. Wade W-6000-1-179-118, Zurn Z-1400-BP-VP, J.R. Smith 4032-U, MIFAB C1100-R-1-6, or approved equivalent.

C. Cleanout: exterior location (YCO):

Cast iron body, threaded adjustable housing, flanged ferrule with straight thread gasketed plug and round secured satin nickel bronze scoriated top. Wade W-6000-1-118, Zurn Z-1400-BP, J.R. Smith 4032, MIFAB C100-S-1, or approved equivalent.

D. Cleanout: wall type for concealed riser in finished spaces (WCO):

Provide cleanout fitting with screwed plug opening and countersunk plug. Provide 8” x 8” square access covers with polished nickel bronze beveled edge frame with anchor lugs for over the wall installation, smooth stainless steel cover, and vandalproof screws. Wade 8480ST-179, Zurn ZANB-1462-8-VP, J.R. Smith 4730-U-NB, MIFAB C1460-S-3-6, or approved equivalent.

E. Cleanout: wall type for concealed riser in unfinished spaces (WCO):

Provide cleanout fitting with screwed plug opening and countersunk plug. Provide round access covers with smooth stainless steel cover, and vandalproof center screw. Wade, Zurn, J.R. Smith, MIFAB, or approved equivalent.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.

2. Size: Same as connected waste piping.

   a. NPS 2: 4-inch-minimum water seal.
   b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.

2. Body: Bronze or cast iron.

3. Inlet: Opening in top of body.

4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

2.4 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.5 FLOOR DRAINS

A. Floor Drain: toilet room (FD-A):
Cast iron body with flashing flange, integral reversible clamping collar, seepage openings, 6” x 6” square adjustable satin nickel bronze, strainer top with vandal proof fasteners and be 3” outlet. Wade W-1103-G6-1-176, Zurn ZN-415-6S-VP, J.R. Smith 2000-B06NB-U-L, MIFAB F1100C-S6-1, or approved equivalent.

B. Floor Drain: mechanical equipment room (FD-B):

Cast iron body with flashing flange, integral reversible clamping collar, seepage openings, 7” cast iron loose set tractor strainer and 3” outlet. Wade W-1103-TS7, Zurn Z-415-7N, J.R. Smith 2000-D-CI, MIFAB F1100C-N-1, or approved equivalent.

C. Floor Drain: interior unfinished floor (FD-C):

Cast iron body with flashing flange, integral reversible clamping collar, seepage openings, 6” round adjustable satin bronze round strainer top, vandalproof. Wade W-110X-STD6-1176, Zurn ZN-415-6B-VP, J.R. Smith 2000-A06NB-U-L, or approved equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting:

1. Comply with requirements for vibration-isolation devices specified in Section 220548 "Vibration Controls for Plumbing Piping and Equipment."

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.

2. Locate at each change in direction of piping greater than 45 degrees.

3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

G. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

H. Install deep-seal traps on floor drains and other waste outlets, if indicated.

I. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.

2. Size: Same as floor drain inlet.

J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

K. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

L. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

M. Install fire-rated wood-blocking reinforcement for wall-mounting-type specialties.

N. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

O. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.

2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.

3. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

P. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.

1. Install on support devices, so that top will be flush with adjacent surface.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign:

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 220500 Basic Plumbing Materials and Methods."

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 22 14 13 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 200800 “Seismic Protection,” Section 220100 “Basic Plumbing Requirements,” and Section 220500 “Basic Plumbing Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.

2. Specialty pipe fittings.

B. Related Sections:

1. Section 220500 “Basic Plumbing Materials and Methods” for transition couplings and dielectric fittings.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: 10-foot head of water.

B. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than two weeks in advance of proposed interruption of storm-drainage service.

2. Do not proceed with interruption of storm-drainage service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Pipe and fittings shall be Made In The U.S.A.

2.2 CAST IRON PIPE AND FITTINGS

A. No hub soil pipe shall be in accordance with ASTM A-888 CISPI 301available with coal tar coating. 5ft and 10ft lengths, range 1-1/2” – 10”

B. Cast iron no hub pipe and fittings.

C. Pressure: Gravity Vented

D. Temperature: 140 degrees.

2.3 SPECIALTY PIPE FITTINGS

A. Transition couplings:

1. See section 220500 “Basic Plumbing Materials and Methods”.

B. Dielectric Fittings:

1. See section 220500 “Basic Plumbing Materials and Methods”.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 200800 “Seismic Protection."

K. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install storm drainage piping at the following minimum slopes unless otherwise indicated:

1. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow for piping NPS 8 and smaller.

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 " Basic Plumbing Materials and Methods."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Basic Plumbing Materials and Methods."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Basic Plumbing Materials and Methods."

3.2 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in ODs.

2. In Drainage Piping: **Unshielded** or **Shielded**, nonpressure transition couplings.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 200800 “Seismic Protection."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 230529 "Hangers and Supports."

C. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.5 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220500 "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

5. Prepare reports for tests and required corrective action.

3.7 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.8 PIPING SCHEDULE

A. Aboveground, soil, waste, and vent piping NPS 8 and smaller shall be the following:

1. Cast-Iron soil pipe, no hub with stainless steel coupling assembly with neoprene rubber gasket.

END OF SECTION 221413

SECTION 22 43 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.

B. Section 200800 “Seismic Protection,” Section 220100 “Basic Plumbing Requirements,” and Section 220500 “Basic Plumbing Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. Section includes the following fixtures and specialties:

1. Water closets.

2. Flushometer valves.

3. Toilet seats.

4. Sinks.

5. Electric Water Coolers

6. Service sinks.

7. Supports.

8. Lavatories.

9. Urinals.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fixtures.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For plumbing fixtures and faucets to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments of flushometer valves electronic sensors.

PART 2 - PRODUCTS

2.1 WATER CLOSETS

A. Toilet: (WC-A)

Vitreous china elongated bowl, 1.28-1.6 gal/flush, siphon-jet, wall-mounted with 1-1/2" (top) inlet spud, High Efficiency Toilet (HET). Conforms to ANSI Standard A112.19.2M fixture dimensions. American Standard "AFWALL Millennium FloWise" model 2257.101, Kohler "Kingston" model K-4325-0, Sloan model ST-2459, Toto CT708E, or Zurn model Z5615-BWL

B. Seat:

Solid plastic, open front less cover for elongated bowl, integral bumpers and external check hinges with stainless steel bolts. Church #9500C. Bemis #1655C.

C. Carrier:

Adjustable anchor foot type for above-the-floor no-hub piping connection for wall hung toilet. Cast iron factory painted adjustable faceplate with corrosion-resistant adjustable waste coupling with neoprene seal and integral test cap. Zinc plated steel fixture studs with vandal proof chrome plated fixture cap nuts and fiber fixture washers. Wade series W-300 or Zurn Series Z-1200-VP, J.R. Smith Series 0200, Watts Series CA-100-M16, MIFAB Series MC-IX.

D. Flush Valve:

Quiet, exposed diaphragm type, closet flushometer, metal oscillating non-hold open handle, 1" IPS screw driver angle stop with protective cap, adjustable tail piece, vacuum breaker flush connection and spud coupling for 1-1/2" top spud, wall and spud flanges. Single flush, Electrical Overide, Battery Sloan model no. SMO 111-16.

E. Toilet (WC-B)

Same specification as standard water closet (WC-A) and accessories, Subsections 22 40 01 through 22 40 10 inclusive, except toilet and flush valve shall be installed in accordance with

ADA Standards requirements for handicapped usage.

F. Toilet (WC-C) STD Floor Mounted

Vitreous china elongated bowl, 1.28-1.6 gal/flush, siphon-jet, floor mounted 15” rim height, with 1-1/2” top inlet spud, High Efficiency Toilet (HET). Conforms to ANSI Standard A112.19.2M fixture dimensions. American Standard “Madera FloWise” model 3451.001, Kohler “Wellcomme Ultra” model K-96053-0, Sloan model ST-2009, Toto CT705EN or Zurn model Z56545-BWL1.

G. Seat:

Solid plastic, open front less cover for elongated bowl, integral bumpers and external check hinges with stainless steel bolts. Church #9500C. Bemis #1655C.

H. Flush Valve:

Quiet, exposed diaphragm type, closet flushometer, metal oscillating non-hold open handle, 1” IPS screw driver angle stop with protective cap, adjustable tail piece, vacuum breaker flush connection and spud coupling for 1-1/2” top spud, wall and spud flanges. Single flush, Electrical Overide, Battery Sloan model no. SMO 111-16.

I. Toilet (WC-D) ADA Floor Mounted

Vitreous china elongated bowl, 1.28-1.6 gal/flush, siphon-jet, floor mounted 17” rim height, with 1-1/2” top inlet spud, High Efficiency Toilet (HET). Conforms to ANSI Standard A112.19.2M, ADA, and ANSI 117-1 fixture dimensions. American Standard “Madera FloWise” model 3043.001, Kohler “Highcliff” model K-96057-0, Sloan model ST-2029, Toto CT705ELN or Zurn model Z5665-BWL.

J. Seat:

Solid plastic, open front less cover for elongated bowl, integral bumpers and external check hinges with stainless steel bolts. Church #9500C. Bemis #1655C.

K. Flush Valve:

Quiet, exposed diaphragm type, closet flushometer, metal oscillating non-hold open handle, 1” IPS screw driver angle stop with protective cap, adjustable tail piece, vacuum breaker flush connection and spud coupling for 1-1/2” top spud, wall and spud flanges. Single flush, Electrical Overide, Battery Sloan model no. SMO 111-16.

2.2 URINALS

A. Urinal :

Vitreous china water saver (1.0 gallons per flush) siphon-jet, wall hung and with ¾" (top) inlet spud, 2"IPS female threaded outlet (rear) connection and wall hanger. Conforms to ANSI Standard A112.19.2 fixture dimensions. American Standard "Trimbrook", model 6561.017. Kohler "Freshman" model K-4989-T or Zurn Z5730.

B. Carrier:

Adjustable height universal plate hanger carrier with rectangular steel uprights, block base anchor feet, upper and lower support plates, and vandalproof cap nuts. Wade W-400-AM11-M36-M3, or Zurn Z-1222, J.R. Smith 0637, Watts CA-321-M53. MIFAB MC-32.

C. Flush Valve:

Quiet exposed urinal flush valve (1.0 gallons per flush), metal oscillating non-hold handle, ¾" IPS screwdriver angle stop with protective cap, adjustable tailpiece, vacuum breaker flush connection and spud coupling for ¾" top spud, wall and spud flanges. Single flush, Electrical Overide, Battery Sloan model no. SMO 186-1.0.

2.3 LAVATORIES

A. Lavatory: L-A

Vitreous china with front overflow, faucet ledge, concealed carrier arms, self-draining deck area with contoured back and side splash shields. Nominal size: 20-1/2" x 18-1/4" with "D" shaped bowl. Faucet holes on 8" centers. Conforms to ANSI Standard A112.19.2 for fixture dimensions. American Standard model "LUCERNE" 0356.015, Kohler "Kingston" model K-2006-0, Sloan model SS-3803, or Zurn model Z5348.

B. Faucet:
8" centers, 5" spout, vandal proof metal lever handles, color-coded index buttons, vandal proof aerator. Chicago Faucet no. 404-317ABCP, Kohler K-7307-KE/K-16012-4, , Zurn Z-831R1-2M or approved equivalent.

C. Trap:

1-1/2" x 1-1/4" x 17 gauge tubular P-trap with clean-out, plug and wall escutcheon.
McGuire Mfg. catalog no. 8902. Dearborn Brass catalog no. 510.

D. Insulation Kit:

Conforms to 28CFR Part 36, Article 4.19.4 (7/26/91). Truebro model no. 103W. Dearborn Brass catalog no. 515KIT.

2.4 SERVICE SINKS

A. Service Sink:

Enameled cast iron, acid resisting with wall hanger and rim guard. Nominal size: 24" x 20" faucet holes on 8" centers through back. Conforms to ANSI Standard A112.19.1M for fixture dimensions. American Standard "AKRON", model #7695.018.

B. Faucet:

8" centers, 8" vacuum breaker rigid spout with ¾" hose thread outlet, lever handles, wall brace and pail hook, ½" FPT inlets with flanges. Chicago Faucet no. 897. Or Zurn Z-841M1.

C. Strainer:

Include with trap.

D. Trap:

3" cast iron threaded connection with removable perforated grid. American Standard model no. 7798.176.

E. Carrier:

Sink carrier with rectangular steel uprights, welded feet, adjustable support plate, and mounting fasteners. Wade W-400-M36 or Zurn Z-1224, J.R. Smith 0800, Watts CA-421.

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2.5 ELECTRIC WATER COOLERS EWC-A

A. Wall mounted, refrigerated, bi-level for general public and handicapped usage with electronic bottle filler. Lower unit shall be wheelchair accessible. Bubbler shall be activated by mechanical push-bar and have built-in pressure regulator for supply pressure range from 20 to 125 psi. All exposed surfaces shall be satin-finish type 304 stainless steel. All waterway components shall be copper construction with lead-free connections. Refrigeration system shall be air-cooled; chill the drinking water in a storage tank type heat exchanger; have an adjustable thermostatic control; be rated to cool 8 gph from 80 deg. F to 50 deg. F at 90 deg. F room temperature; be certified by ARI, UL and CSA and comply with all local building codes and ADA Requirements. Cooler shall include Antimicrobial filter. Elkay Model no. LAZTLL8WSLK or approved equal from Oasis or Halsey Taylor.

B. For masonry construction applications, Plumbing Contractor will mount water cooler directly to wall using factory supplied mounting box. For non-masonry applications, provide and mount using Wade W-440-A11-M36, Zurn 1225-BL, J.R. Smith 0830, or Watts CA-421-HFH.

2.6 SINK S-A

A. 18 gauge, type 302 stainless steel, self-rim single bowl sink. Inside bowl dimensions: 21" x 15-3/4" x 7-1/2". Faucet deck with (1) centered hole Elkay model #LR-2522, Just FSL-2225-A-GR.

B. Faucet

Single-handle kitchen faucet. Kohler Purist K-24982 or Delta or Zurn Approved equivalent.

C. Strainer:

Stainless steel crumb basket with rubber stop for 3-1/2" drain opening and 1-1/2" OD brass tailpiece. Elkay model No. LK-35, Just J-35.

D. Supplies:

Loose keyed ball valve angle stops with lock shield caps and ½" (nominal) copper solder (5/8" ODS) inlet x 3/8" OD outlet x 12" long flexible risers. Provide cast brass escutcheons. Chicago Faucets model STB-41-11-AB, or approved equivalent by McGuire, Dearborn, Brass Craft, Engineered Brass, or Kohler.

E. Trap:

1-1/2" x 17 gauge tubular P-trap with cleanout plug and wall escutcheon. McGuire Mfg. catalog no. 8912.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Install plumbing fixtures level and plumb according to roughing-in drawings & manufacturer's instructions.

B. Install supports, affixed to building substrate, for wall-mounted fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.

2. Use carrier supports without waste fitting for fixtures with tubular waste piping.

3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install counter-mounted fixtures in and attached to casework.

D. Install water-supply piping with stop on each supply to each fixture, including showers, to be connected to water-distribution piping. Attach supplies to supports or substrate within pipe spaces

behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball or gate valve if supply stops are not specified with fixture. Comply with valve requirements specified in Section 220523 "Ball Valves."

E. Install flushometer valves on water closets & urinals.

F. Install flushometer valves for accessible water closets & urinals with lever handle mounted on wide side of compartment.

G. Install toilet seats on water closets.

H. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts, if faucets are not available with required rates and patterns. Include adapters if required.

I. Install laminar-flow, faucet-spout fittings in faucet spouts where laminar-flow fittings are specified.

J. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

K. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220700 "Plumbing Piping Insulation."

L. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

M. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 “Valves.."

N. Install accessible plumbing fixtures at handicapped/elderly mounting heights according to ICC/ANSI A117.1.

O. Install an ASSE 1070 mixing device at each point of use location for every public lavatory.

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with requirements for water piping specified in Section 221116 "Domestic Water Piping."

C. Comply with requirements for soil and waste drainage piping and vent piping specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Comply with requirements for atmospheric vent piping specified in Section 221316 "Sanitary Waste and Vent Piping."

E. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.4 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning plumbing fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. After installing plumbing fixtures, inspect and repair damaged finishes.

B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed fixtures and fittings.

D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224300

SECTION 230100 – BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 23.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:

1. Submittals.
2. Material and Equipment Selection.
3. Coordination drawings.
4. Record documents.
5. Maintenance manuals.
6. Construction IAQ Management.

1.3 SUBMITTALS

A. Prepare and submit Coordination Drawings as further described herein. The Engineer shall receive one copy of all coordination drawings supplied to the Owner as required in this specification. It is the responsibility of the Contractor to coordinate the work as outlined herein. Receipt by the Engineer of a copy of the Coordination Drawings is to verify conformance to the submittal requirements set forth in this specification section. It is not an admission by the Engineer as to the accuracy or completeness of the coordination proposed.

B. Comply with each individual Division 23 Section for additional submittal requirements.

1.4 REFERENCED STANDARDS

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers. Guideline 4-12019 *Preparation of Operating and Maintenance Documentation for Building Systems*. Atlanta, GA: ASHRAE, 2019.

B. Sheet Metal and Air Conditioning Contractors' National Association. *IAQ Guidelines for Occupied Buildings Under Construction*. Chapter 3. Chantilly, VA: SMACNA, 2008.

1.5 MATERIAL AND EQUIPMENT SELECTION

A. Product Options: The specification of each item of major mechanical equipment required for the project may include a list of manufacturers, with one “basis of design” manufacturer, type, and model identified by virtue of their listing in the equipment schedule on the Drawings. Where several manufacturers in addition to the “basis of design” manufacturer are listed in the specifications, it shall be understood that the words “or approved equal by” are implied to precede each of the other manufacturer’s names. The Contractor shall note that the requirements of Division 01, Special Conditions, Substitutions and Equal governs when the requirements of this section are in conflict with the referenced Division 1 requirements.

1. The manufacturers other than the “basis of design” may be furnished at the contractor’s option in lieu of the “basis of design” product, provided that the selected manufacturer’s product is equal in all material and functional respects. In addition to submittal requirements that may be specified in this section, submit a line-by-line written verification of the applicable specification section(s) identifying compliance with or variations from the specified features, materials, performance, capacities, weight, size, durability, energy consumption and efficiency, warranty, and visual impact (if exposed to view by other than maintenance persons). The burden of proof of manufacturer/product equality is on the contractor.

2. Where a product is not scheduled on the drawings and, therefore, where no “basis of design” is indicated, selection among all of the listed manufacturers and products is at the contractor’s option, subject to the requirements of the Contract Documents.

3. Products of manufacturers not listed in the Contract Documents are considered Substitutions and are not permitted, except as provided under the General and Special Conditions.

B. Listing of a manufacturer does not imply approval of that manufacturer’s standard product or products. Rather, listing of a manufacturer indicates only a general acceptance of that manufacturer’s name and reputation. Final approval is subject to full compliance with these Contract Documents.

C. Model numbers identified on the Drawings notwithstanding, all equipment must comply with the requirements of these Contract Documents. Do not assume that a manufacturer’s standard product is acceptable as is. For example, one or more custom modifications, custom colors or finishes, manufacturer’s options, and/or accessories may be required to meet the specified requirements.

D. Where drawings indicate sizes, profiles, connections, and dimensional requirements of material and equipment, these are based on the “basis of design” manufacturer, type and model indicated. In the event that equipment of power, dimensions, capacities, layout, connections, and/or ratings differing from the “basis of design” are selected by the contractor and approved by the Owner’s representative, any necessary adjustments are the contractor’s responsibility. All connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, pipe and duct sizes, pipe and duct layout, and the like shall be adjusted by the contractor to suit the equipment provided. No additional costs will be approved for these changes. Should revisions to the design because of contractor’s selection of manufacturer, type, or model other than the “basis of design” require additional review and/or redesign by an Architect or Engineer, the contractor shall reimburse the Owner for Owner’s added professional fee expenses.

E. Where two or more materials are listed in the “Part 2 – Products” subsection of any Division 23 section, do not assume that the selection of materials is the contractor’s option. Refer to “Part 3 – Execution” subsection of that same Division 23 section for an explanation of which specific material(s) shall be used for which specific application(s). For example, Part 2 may list several types and grades of piping, and Part 3 will describe which type and grade of pipe to use for a given application.

1.6 COORDINATION DRAWINGS

A. Prepare project coordination drawings to a scale of 1/4" = 1'0" or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement. Include all piping including but not limited to HVAC piping, plumbing piping, and fire protection piping. Include ceiling and wall-mounted access doors and panels required to provide access to valves and other operating devices.

2. Planned ductwork layout, including terminal units, dampers and specialty locations, with terminal unit and damper operator clearances. Include ceiling and wall-mounted access doors and panels required to provide access to dampers and other operating devices. Unless otherwise noted, all ductwork shall be install above all other services as high as possible. Provide access to all types of dampers.

3. Clearances for installing and maintaining insulation.

4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.

5. Equipment and accessory service connections and support details.

6. Exterior wall and foundation penetrations.

7. Fire-rated wall and floor penetrations.

8. Sizes and location of required concrete pads and bases.

9. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.

10. Floor plans, elevations, and details to indicate penetrations in floors, walls, ceilings and roofs, and their relationship to other penetrations and installations.

11. Ceiling plans showing coordination of mechanical, electrical, structural, ceiling suspension assembly, lighting, security, communications, fire alarm, plumbing, and fire protection work within allotted space.

12. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, access panels, special moldings, and other ceiling-mounted items.

13. Floor plans and sections of mechanical rooms; show layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

14. Floor plans and sections of fan coil units located in study rooms and lounges and blower coil units located in mechanical closets serving apartments. Show layout and relationship between risers drain valves in closet of lowest level fan coil unit and access panel.

15. Attic Plans: Ductwork routed through attic space. Ductwork routed through structural truss webbing. Ductwork routed to maintain seven foot clear floor to floor for service walkway access through attic.

1.7 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:

1. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.

2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Indicate actual inverts and horizontal locations of all underground piping.

3. Valve location diagrams, complete with valve tag chart. Refer to Division 23 Section “Basic Mechanical Materials and Methods.”

4. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

5. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

6. Contract Modifications, actual equipment and materials installed. Modify all equipment schedule sheets with installed materials model numbers and all performances.

1.8 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 01. In addition to the requirements specified in Division 01, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

B. In addition to the above, comply with ASHRAE Guideline 4-2008 *Preparation of Operating and Maintenance Documentation for Building Systems*.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 CONSTRUCTION IAQ MANAGEMENT

A. During construction, meet or exceed the recommended Design Approaches of SMACNA *IAQ Guideline for Occupied Buildings under Construction*.

B. Protect stored on-site or installed absorptive materials from moisture damage. Materials directly exposed to moisture via precipitation, water leaks, or condensation shall be removed from the jobsite and replaced.

C. Building Flush-Out: After construction ends but prior to occupancy, conduct a minimum two-week building flush-out using permanent building ductwork and air handling equipment. Flush-out shall be made with 100% outdoor air and MERV-13 or better filtration media. If extremes of cold, hot, or humid weather are anticipated during flush-out, participate with design professional in formulating a climate control plan.

D. Replace all filtration media immediately prior to occupancy, using MERV-13 or better filtration media.

E. Document Construction IAQ Management activities. Such documentation shall include, as a minimum:

1. List each air filter used during construction. Include the MERV value, manufacturer name and model number, and a designation of where used on this project.

2. List each air filter installed at the end of construction. Include the MERV value, manufacturer name and model number, and a designation of where used on this project.

3. Provide 18 photographs (six photographs taken on three different occasions during construction), along with identification of the SMACNA approach featured by each photograph, in order to show consistent adherence to the SMACNA Guideline.

END OF SECTION 230100

SECTION 230500 – BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 20 0800 “Seismic Protection” and Section 230100 “Basic Mechanical Requirements” applies to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections.

1. Materials and installation instructions common to mechanical systems.
2. Pipe joining materials and methods.
3. Flexible pipe connectors.
4. Mechanical sleeve seals.
5. Pipe sleeves.
6. Escutcheons.
7. Labeling and identifying mechanical systems and equipment.
8. Non-shrink grout for equipment installations.
9. Painting and finishing of mechanical work.
10. Concrete base construction requirements.
11. Coordination with Structural work.
12. Field-fabricated metal equipment supports.
13. Selective Demolition.
14. Cutting and patching.

B. Pipe and pipe fitting materials are specified in individual Division 21- 23 piping system Sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. NP: Nylon plastic.

2. PE: Polyethylene plastic.

3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. CR: Chlorosulfonated polyethylene synthetic rubber.

2. EPDM: Ethylene propylene diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For flexible pipe connectors and mechanical sleeve seals.

B. Coordination Drawings: For access panel and door locations.

C. QUALITY ASSURANCE

D. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

E. Welding: Qualify welding processes and operators for structural steel according to AWS D1.1 “Structural Welding Code – Steel.”

F. Welding: Qualify welding processes and operators for piping according to ASME “Boiler and Pressure Vessel Code,” Section IX, “Welding and Brazing Qualifications.”

1. Comply with provisions of ASME B31 Series “Code for Pressure Piping.”

2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

3. Contactor shall retain all welding certificates on file and produce them for review upon request by the Owner and/or Owner's representative.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor or roof, if stored thereupon.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

E. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

G. Coordinate connection of electrical services.

H. Unless otherwise noted, install all ductwork above all other systems. Coordinate with all other disciplines. Provide required access to duct mounted access doors and dampers.

I. Dielectric fittings are not allowed. Install bronze shutoff valve where dissimilar metals are joined. Valve must be installed in an accessible area or above an access panel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexible Pipe Connectors (Metal):

    a. Grinnell Corp.; Grinnell Supply Sales Co.
    b. McWane, Inc.; Tyler Pipe; Gustin-Bacon Div.
    c. Mercer Rubber Co.
    d. Metraflex Co.
    e. Proco Products, Inc.
    f. Uniflex, Inc.
    g. Twin City Hose.

2. Mechanical Sleeve Seals:

    a. Calpico, Inc.
    b. Metraflex Co.
    c. Advance Products & Systems; Innerlynx.
    d. Thunderline/Link-Seal.

3. Identifying Devices and Labels:

    a. Brady USA, Inc., Signmark Div.
    b. Brimar Industries, Inc.
    c. Kolbi Industries, Inc.
    d. Panduit Corp.
    e. Seton Name Plate Co.

2.2 PIPE AND PIPE FITTINGS

A. Refer to individual Divisions 21-23 piping Sections for pipe and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Joining Materials: Carbon steel bolts and nuts. Gasket suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8-inch (3.2 mm) thick, unless otherwise indicated, and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B32 lead-free alloys. Include water-flushable flex according to ASTM B813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements: Manufacturer's standard solvent cements for the following:

1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

H. Transition Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.

1. Sleeve: ASTM A 126, Class B, gray iron.

2. Followers: ASTM A 47 (ASTM A 47M) malleable iron or ASTM A 536 ductile iron.

3. Gaskets: Rubber.

4. Bolts and Nuts: AWWA C111.

5. Finish: Enamel paint.

2.4 FLEXIBLE PIPE CONNECTORS

A. General: Sometimes referred to as “flexible connectors” on Drawings. Fabricated from materials suitable for system fluid and that will provide pump pipe connections. Include 125-psig (860-kPa) minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:

1. 2-Inch NPS (DN50) and Smaller: Threaded.

2. 2½-Inch NPS (DN65) and Larger: Flanged.

B. Stainless-Steel-Hose/Stainless-Steel Pipe, Pump Connectors: Corrugated, stainless steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

C. Active (Live) Length: 12 inches for nominal pipe sizes 2½ inches and smaller; 18 inches for nominal pipe sizes 3 – 4 inches; 24 inches for larger nominal pipe sizes. (Active or Live Length is end-to-end less total fitting length minimum.)

D. Flexible pipe connectors specified herein are for use at the piping connection to a piece of mechanical equipment, including but not limited to pumps. These are not acceptable for use

where “expansion joints” or “pipe expansion fittings” are called out. Refer to Division 23 Section “Pipe Expansion Fittings” for pipe expansion joints or pipe expansion fittings.

2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Stainless steel. Include two for each sealing element.

D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 PIPE SLEEVES

A. The following sleeve materials are for wall, floor, slab, and roof penetrations.

B. Steel Pipe: ASTM A53, Type E, Grade A, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated “wall pipe” equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

E. Contractor’s Option: Pre-engineered, UL-listed fire-resistance rated and watertight cast-in-place floor sleeving systems meeting the following specifications will be acceptable in lieu of traditional floor sleeves with field-installed firestop, at contractor’s option.

1. Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in concrete floors formed with steel decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, fire, and hot gasses.

2. Manufacturer: Subject to compliance with requirements, provide Hydroflame™ sleeving system by Hubbard Enterprises / Holdrite; or approved equal.

3. Include an outer sleeve lined with an intumescent strip; and a radial extended flange attached to one end of the sleeve for fastening to concrete formwork; or wide outside wings attached to one end of the sleeve for fastening to metal deck concrete formwork and span deck corrugations.

4. Include a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab. For applications involving a corrugated deck, also include a cone attached to the base for extending the device through the metal deck.

5. Product shall provide a two-hour fire-resistance rated assembly when tested according to ASTM E 814 or ANSI/UL 1479.

2.7 ESCUTCHEONS

A. General: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw and polished chrome-plated finish.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw and polished chrome-plated finish.

E. One-Piece, Stamped-Steel Type: With spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.8 IDENTIFYING DEVICES AND LABELS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 21-23 Sections. If more than one type is specified for application, selection is installer's option, but provide one selection for each product category.

B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment; furnished and factory-installed by original equipment manufacturer.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.

2. Location: Accessible and visible location.

C. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, complying with ASME A13.1.

D. Plastic Duct Markers: Manufacturer's standard color-coded, laminated plastic. Comply with the following color code:

1. Green: Cold air.

2. Yellow: Hot air.

3. Yellow/Green or Green: Supply air.

4. Blue: Exhaust, outside, return, and mixed air.

5. For hazardous exhausts, use colors and designs recommended by ASME A13.1.

6. Nomenclature: Include direction of airflow and duct service.

E. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated.

1. Fabricate in sizes required for message.

2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.

3. Punch for mechanical fastening.

4. Thickness: 1/16-inch (1.6 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) long; 1/8-inch (3.2 mm) for larger units.

5. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.

6. Provide signs at all Fire/Smoke Dampers. Install at location unobstructed to view in rooms. Use numbers, letting and wording indicated on Fire Smoke Damper Schedule sheets of Construction Documents.

F. Valve Tags: Stamped or engraved with 1/4-inch (6-mm) letters for piping system abbreviation and 1/2-inch (13-mm) sequenced numbers. Include 5/32-inch (4-mm) hole for fastener.

1. Material: 3/32-inch (2.4-mm) thick plastic laminate with 2 black surfaces and a white inner layer.

2. Size: 1½-inches (40-mm) diameter, unless otherwise indicated.

G. Valve Tag Fasteners: Brass, wire-link chain; beaded chain; or S-hooks.

H. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.

1. Multiple Systems: If multiple systems of same generic name are indicated, provide identification that indicates individual system number and service such as "Boiler No. 3," "Air Supply No. 1H," or "Standpipe F12."

2.9 CONCRETE AND GROUT

A. Concrete: For all minor concrete work required for mechanical installations, such as concrete equipment bases and supports, refer to Division 03 Sections for specification of cast-in-place concrete and reinforcing materials, whose requirements apply to the work of Division 23 as if fully reproduced herein.

B. Non-shrink, Non-metallic Grout: ASTM C1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psig (34.5-MPa), 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.10 PAINTING AND FINISHING

A. For all painting and finishing work required for mechanical installations, as described in Part 3 of this Section and/or on the Drawings, refer to Division 09 Sections for specification of paint and finishing materials, whose requirements apply to the work of Division 23 as if fully reproduced herein.

PART 3 - EXECUTION

3.1 GENERAL MECHANICAL INSTALLATION REQUIREMENTS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements.

B. Coordinate mechanical systems, equipment, and materials installation with other building components.

C. Verify all dimensions by field measurements.

D. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.

E. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

F. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

G. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

H. Coordinate connection of mechanical systems with exterior underground services. Provide required connection for each service.

I. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

J. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

K. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

L. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

M. Unless otherwise noted, install all ductwork above all other systems. Coordinate with all other disciplines. Provide required access to duct mounted access doors and dampers.

3.2 PIPING SYSTEM INSTALLATION REQUIREMENTS

A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 23 piping Sections specify unique piping installation requirements.

B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.

C. Install piping at indicated slope.

D. Install and arrange piping to permit valve servicing.

E. Install components with pressure rating equal to or greater than system operating pressure.

F. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

G. Install piping free of sags and bends.

H. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

I. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

J. Electrical Equipment Spaces: Route piping to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

K. Install piping to allow application of insulation plus 1-inch (25-mm) clearance around insulation.

L. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

M. Install fittings for changes in direction and branch connections.

N. Install couplings according to manufacturer's written instructions.

O. Piping Support: As specified in Division 23 Section "Hangers and Supports."

P. All flexible pipe connectors shall be installed in accessible locations. Shut-off valve shall be installed between pipe main and flexible connector.

3.3 PIPING JOINING REQUIREMENTS

A. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.

3. Align threads at point of assembly.

4. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.

5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.

1. Apply one coat of self-priming, rust-inhibitor paint around the entire circumference of each welded pipe joint; regardless of whether or not the piping is specified to be painted. Paint may be brush-applied, roller-applied, or spray-applied at contractor's option.

H. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. PVC Pressure Piping: ASTM D2672.

3. PVC Non-pressure Piping: ASTM D2855.

J. Piping Connections: Make connections according to the following, unless otherwise indicated.

1. Install unions, in piping 2-inch NPS (DN50) and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS (DN50) or smaller threaded pipe connection.

2. Install flanges, in piping 2½-inch NPS (DN65) and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.

3. Dry Piping Systems: Install brass shutoff valve to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install brass shutoff valve to connect piping materials of dissimilar metals.

5. Valve Caps: Any valve that represents a termination or the end of a run (e.g., blowdown or drain valve, hose-end valve, etc.) shall be fitted with a permanent but removable cap, plug, or blind flange matching the valve construction, to minimize risk in the event the valve is accidentally opened under pressure.

6. Install shut off valve between hydronic riser and flexible pipe connector. All shut off valves must be accessible.

7. Connect copper branch lines to steel or iron mains as follows: Install steel branch pipe off main with black iron nipple connected to bronze ball valve. Connect bronze ball valve to copper piping with threaded copper male adaptor, which is then soldered to the copper branch line.

8. Provide shutoff valves at each floor and/or branch on hot water reheat systems.

3.4 PIPE-PENETRATION INSTALLATION REQUIREMENTS

A. Install escutcheons for new piping penetrations of walls, ceilings, and floors according to the following:

1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

2. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

3. Insulated Piping: One-piece, stamped-steel type with spring clips.

4. Uninsulated Piping in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

5. Uninsulated Piping in Unfinished Spaces: One-piece, cast-brass type.

6. Uninsulated Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

B. Install sleeves for pipes passing through concrete and masonry walls, and concrete floor.

C. Cut sleeves to length for mounting flush with both surfaces.

1. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

D. Build sleeves into new walls and slabs as work progresses.

E. Install sleeves large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

1. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS (DN150).

2. Seal space outside of sleeve fittings with non-shrink, non-metallic grout.

F. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division 07 Section “Joint Sealants” for materials.

1. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.

G. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.

2. Install cast-iron “wall pipes” for sleeves 6 inches (150 mm) in diameter and larger.

3. Assemble and install mechanical sleeve seals according to manufacturer’s written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.

H. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron “wall pipes” for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Assemble and install mechanical sleeve seals according to manufacturer’s written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.

I. Sleeves are not required for core-drilled holes.

J. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials. Refer to Division 07 Section “Penetration Firestopping” for materials.

3.5 EQUIPMENT INSTALLATION REQUIREMENTS

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Division 23 and Division 26 for rough-in requirements.

C. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

D. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.

E. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

F. Positive attachment and anchorage of all equipment to the structure or floor is required. Do not rely on friction or gravity as a means of attachment.

G. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

H. Install equipment giving right of way to piping installed at required slope.

I. Install flexible pipe connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

J. Support for Suspended Equipment: As specified in Division 23 Section “Hangers and Supports.”

3.6 LABELING AND IDENTIFYING

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow. Use plastic markers, with application systems. Install on insulation segment if required for hot, uninsulated piping.

B. Locate pipe markers as follows if piping is exposed in finished spaces, machine rooms, and accessible maintenance spaces, such as shafts, tunnels, plenums, and exterior non-concealed locations:

1. Near each valve and control device.

2. Near each branch, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, if flow pattern is not obvious.

3. Near locations where pipes pass through walls, floors, ceilings, or enter non-accessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum of 50-foot (15-m) intervals along each run. Reduce intervals to 25 feet (7.5 m) in congested areas of piping and equipment.

7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

8. Plastic tape pipe markers: Maximum VOC limit 50g/L.

C. Install continuous plastic underground warning tapes during back filling of trenches for underground piping. Locate 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping.

D. Equipment: Install engraved plastic-laminate sign on or near each major item of mechanical equipment and all fire/smoke dampers.

1. Lettering Size: Minimum 1/4-inch- (6.4-mm-) high lettering for name of unit if viewing distance is less than 24 inches (610 mm), 1/2-inch- (12.7-mm-) high lettering for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.

2. Text of Signs: Provide name of identified unit. Include text to distinguish between multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

E. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers showing duct system service and direction of flow.

1. Location: In each space, if ducts are exposed or concealed by removable ceiling system, locate signs near points where ducts enter into space and at maximum intervals of 50 feet (15 m).

F. Adjusting: Relocate identifying devices as necessary for unobstructed view in finished construction.

G. Install valve tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, faucets, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units.

3.7 PAINTING AND FINISHING

A. For all painting and finishing work required for mechanical installations, refer to Division 09 Sections for application requirements.

B. Painting of exposed mechanical installations in finished spaces, including but not limited to pipe, fittings, valves, hangers, ductwork, insulation, equipment, supports, etc., as specified in Division 09 Section “Finishes.” In addition, paint the following:

1. Duct, equipment, and pipe insulation having ASJ or other paintable jacket material.

2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

C. In addition to Division 09 requirements, painting of exposed mechanical work in unfinished spaces is required according to the following, unless otherwise indicated:

1. Interior uninsulated ferrous piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.

2. Interior uninsulated galvanized-steel piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.

3. Interior, ferrous supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.

4. Exterior uninsulated ferrous piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.

5. Exterior uninsulated galvanized-steel piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.

6. Exterior, ferrous supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.

D. Each pipe shall be painted a designated color according to service. Owner's standard color scheme will be provided and shall be followed.

E. Do not paint piping specialties with factory-applied finish.

F. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 CONCRETE BASES

A. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to Division 20 Section "Seismic Protection."

B. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.

C. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.

D. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

E. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

F. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

H. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03.

3.9 COORDINATION WITH STRUCTURAL WORK

A. Concrete: Do not embed pipes, wires, tube, boxes, ducts or other cavity-creating elements in concrete work unless shown on or permitted by the structural drawings.

1. Openings through concrete not shown on the structural drawings are subject to approval by the structural engineer of record. See coordination drawing requirements under Submittals.

B. Roof: Do not place loads on, or hang any loads whatsoever from roof, unless shown on structural drawings, including, but not limited to, hangers for pipes, ducts, equipment, etc. Trade contractor installing such loads shall provide sub-framing connected to steel frame.

1. Do not exceed capacity of roof as a working platform. Submit all proposed construction loads to deck supplier for approval.

2. Openings in roof not shown on structural drawings, such as openings required for stacks, pipes, ducts, plumbing vents, etc., shall be cut and reinforced by trade requiring opening.

C. Supported Slab: Do not suspend loads exceeding 500 pounds within any 100 square feet of contiguous area from concrete supported slab. Suspend such loads from structural steel only. Any “sub-framing” required is responsibility of Contractor or sub-contractor installing material requiring support.

1. Openings in concrete floor slabs not shown on structural drawings, such as openings required for stacks, pipes, ducts, plumbing vents, etc., shall be the responsibility of the trade requiring openings. Form blockouts in the slab, reinforcing deck, and cut openings after concrete has reached specified strength.

2. Where openings larger than 12-inches are required but not shown on structural drawings, secure written approval from Architect/Engineer prior to cutting deck.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1, “Structural Welding Code – Steel.”

3.11 SELECTIVE DEMOLITION

A. Disconnect, demolish, and remove mechanical work as indicated on the Drawings, and as required for installation of new work shown.

1. Coordinate with Division 26 for disconnection of power to electrically-powered equipment prior to demolition.

B. Remove accessible work in its entirety. Repair cut surfaces to match adjacent surfaces. Abandon in place embedded or buried work, unless noted otherwise.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

5. Equipment to Be Removed: Disconnect and cap services and remove equipment.

C. Removal: Unless otherwise indicated, remove demolished pipe, duct and equipment from the Project site. Handle and dispose of in accordance with National, State, and Local regulations.

1. Relocation: Remove, store, clean, reinstall, reconnect, and make operational all work indicated for relocation.

2. Salvage: Remove and deliver to Owner all work indicated for salvage.

D. Refer to Division 01 Sections “Selective Demolition” and/or “Selective Structure Demolition” for additional requirements.

E. For selective demolition of any appliance or piece of equipment containing a CFC, HCFC, or HFC refrigerant: Prior to demolition, refrigerant shall be evacuated and captured in full compliance with the Clean Air Act; using only technicians with the proper refrigerant license as according to law, stored in approved containers, and shipped to a licensed refrigerant recycling facility all as required by the United States Environmental Protection Agency.

3.12 CUTTING AND PATCHING

A. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay. Perform cutting and patching in accordance with the following:

B. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

C. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work.

2. Remove and replace defective Work.

3. Remove and replace Work not conforming to requirements of the Contract Documents.

4. Install equipment and materials in existing structures.

D. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, pumps, and other mechanical items made obsolete by the new Work.

E. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

F. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

G. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

H. Repair cut surfaces to match adjacent installations.

I. Repair any building insulation or building fireproofing materials, whether new or existing, that are removed or scraped away in order to make a mechanical installation, so as to maintain an equivalent insulation or fire rating as existed without said mechanical installation.

J. Refer to Division 01 Sections “Execution” and/or “Cutting and Patching” for additional requirements.

3.13 GROUTING

A. Install nonmetallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Mix grout according to manufacturer's written instructions. Clean surfaces that will come into contact with grout.

C. Clean surfaces that will come into contact with grout.

D. Provide forms as required for placement of grout.

E. Place grout, completely filling equipment bases. Avoid air entrapment during placing of grout. Place grout on concrete bases to provide smooth bearing surface for equipment. Place grout around anchors.

F. Cure placed grout according to manufacturer's written instructions.

END OF SECTION 230500

SECTION 230513 – MOTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 230100 “Basic Mechanical Requirements” and Section 230500 “Basic Mechanical Materials and Methods” apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes basic requirements for factory-installed motors associated with mechanical equipment specified elsewhere in Division 23.

B. In addition, this Section fully applies to the work of Division 21 and 22.

C. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer’s factory or shipped separately by equipment manufacturer for field installation.

D. Related Sections include all other Division 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

1.3 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

1.4 SUBMITTALS

A. Product Data: Submit motor product data with each associated equipment submittal. Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. UL Listing: Motors specified in this Section must be listed and labeled by Underwriters Laboratories and bear the UL logo.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:

1. Compatible with magnetic controllers, multi-speed controllers, and/or reduced-voltage controllers where applicable.

2. Designed and labeled for use with variable frequency controllers where applicable and suitable for use throughout speed range without overheating.

3. Matched to torque and horsepower requirements of the load.

4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Baldor Electric Co.

2. General Electric Co.

3. Reliance Electric Co.

2.2 BASIC MOTOR REQUIREMENTS

A. Basic requirements apply to mechanical equipment motors, unless otherwise indicated.

B. Motors 1/2 HP and Larger: Polyphase.

C. Motors Smaller than 1/2 HP: Single phase.

D. Frequency Rating: 60 Hz.

E. Voltage Rating: NEMA standard voltage selected to operate on nominal voltage of circuit to which motor is connected.

F. Service Factor: According to NEMA MG 1, unless otherwise indicated, but at least 1.15 polyphase motors and 1.35 for single-phase motors.

G. Duty: Continuous duty at ambient temperature of 104°F and at altitude of 3300 ft above sea level.

H. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

I. Enclosure: Open drip-proof, unless otherwise indicated.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, medium induction motor.

B. Design Characteristics: NEMA MG 1, Design E, unless otherwise indicated.

C. Energy-Efficient Design: Premium efficiency motors as defined in NEMA MG 1; Part 31. In addition, motors shall meet efficiency levels defined in Tables 12-12 and 12-13 of MG 1-2006.

D. Stator: Copper windings, unless otherwise indicated.

E. Rotor: Random-wound, squirrel cage, unless otherwise indicated.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating, unless otherwise indicated.

H. Insulation: Class F, unless otherwise indicated.

I. Code Letter Designation:

1. Motors 15 HP and larger: NEMA starting Code F or Code G.

2. Motors under 15 HP: Manufacturer's standard starting characteristics.

J. Enclosure: Cast iron for motors 7½ HP and larger; rolled steel for motors smaller than 7½ HP; with enamel finish.

K. Motor efficiencies for motors one horsepower and greater shall be as indicated in the table below, but in no case shall be less efficient than "Premium Efficiency" as defined in NEMA MG 1; Part 31. Motors shall be tested and labeled in accordance with NEMA MG 1-2006 Part 12 Table 12-12 Standard. Motor nameplate labeling shall include both the minimum and nominal efficiency.

L. Required Motor Performance: Efficiencies indicated below are required for 1800-rpm (4-pole) open motors.

HP	Minimum Power Factor	Nominal Efficiency	Minimum Efficiency
1	84%	85.5%	82.5%
1½	84%	86.5%	84.0%
2	84%	86.5%	84.0%
3	85%	89.5%	87.5%
5	85%	89.5%	87.5%
7½	85%	91.0%	89.5%
10	85%	91.7%	90.2%
15	85%	93.0%	91.7%
20	85%	93.0%	91.7%
25	85%	93.6%	92.4%
30	85%	94.1%	93.0%
40	85%	94.1%	93.0%
50	85%	94.5%	93.6%
60	85%	95.0%	94.1%

M. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

N. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Designed with critical vibration frequencies outside operating range of controller output.

2. Temperature Rise: Matched to rating for Class B insulation.

3. Insulation: Class F or H.

4. Motor shall be inverter-duty or inverter-ready and shall not require the use of external cooling fans.

O. Shaft Grounding Ring: On any and all motors to be controlled by a Variable Frequency Motor Controller, include an engineered ring consisting of two or more rows of circumferential conductive microfibers to redirect shaft current and provide a low-impedance path from shaft to frame, bypassing the motor bearings. Factory-install on the motor shaft by sliding the ring over either end, and lock it in place with mechanically-fastened mounting brackets. Motors over 100 nameplate horsepower shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor.

P. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.

2. For motors with other than 2:1 speed ratio, separate winding for each speed.

Q. Source Quality Control: Perform the following routine tests according to NEMA MG 1:

1. Measurement of winding resistance.

2. No-load readings of current and speed at rated voltage and frequency.

3. Locked rotor current at rated frequency.

4. High-potential test.

5. Alignment.

2.4 SINGLE-PHASE MOTORS

A. Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.

1. Permanent-split capacitor.

2. Split-phase start, capacitor run.

3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: Do not use, unless motors are smaller than 1/20 hp.

C. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

D. Thermal Protection: Where indicated or required, internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.

E. Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, pre-lubricated sleeve bearings for other single-phase motors.

2.5 ELECTRICALLY-COMMUTATED MOTORS

A. General: Electrically-Commutated Motors (ECM) are required wherever indicated in other Division 23 Specifications and/or notations on the Drawings.

B. Motor: Motor shall be ECM, variable-speed, DC type, brushless motor designed for fan applications with heavy duty permanently lubricated ball bearings and electric commutation. It shall contain internal circuitry that converts single phase power into a DC signal. Motor shall be designed for direct-drive applications.

C. Speed Control: The ECM shall be speed-controllable down to 20% of full speed via exterior-mounted field-adjustable potentiometer dial or DDC control signal input.

D. Efficiency: Minimum 70% at all speeds.

E. Voltage: Single-phase 115-V or 277-V as indicated.

F. Rotor: Synchronous; permanent magnet type; built-in soft start.

G. Thermal Protection: Where indicated or required, internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, ALL MOTORS

A. Use adjustable motor mounting bases for belt-driven motors.

B. Align motors, bases, shafts, pulleys, and belts. Tension belts according to manufacturer's written instructions.

C. Verify bearing lubrication.

D. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.

E. Test interlocks and control and safety features for proper operation.

F. Verify that current and voltage for each phase comply with nameplate rating and NEMA MG 1 tolerances.

G. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION 230513

SECTION 230519 – METERS AND GAGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 20 0800 “Seismic Protection,” Section 230100 “Basic Mechanical Requirements” and Section 230500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.

2. Thermowells.

3. Pressure gages.

4. Test plugs.

B. Related Sections:

1. Meters, thermometers, and gages furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division 23 Sections.

2. This Section does not include meters and gages associated with a building energy management or control system; those devices are specified in Division 23 Section “Control Systems.”

1.3 SUBMITTALS

A. Product Data: Submit product data for each type of meter, gage, and fitting specified. Include scale range, ratings, and calibrated performance curves. Submit a meter and gage schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gage.

B. Product Certificates: For each type of meter and gage, from manufacturer.

C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of thermometers and gages.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Thermometers and Pressure Gages:

    a. Ernst Gage Co.
    b. Marsh Bellofram.
    c. Miljoco Corp.
    d. H.O. Trerice Co.
    e. Weiss Instruments, Inc.
    f. Weksler Glass Thermometer Corp.

2. Test Plugs:

    a. Flow Design, Inc.
    b. Miljoco Corporation.
    c. Peterson Equipment Co., Inc. (“Pete’s Plugs”)
    d. Sisco Manufacturing Company, Inc.
    e. H.O. Trerice Co.
    f. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
    g. Weiss Instruments, Inc.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Standard: ASME B40.200.

B. Case: Cast aluminum; 9-inch (229-mm) nominal size unless otherwise indicated.

C. Case Form: Adjustable angle; 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device

D. Tube: Glass with magnifying lens and blue organic mineral spirit fill.

E. Tube Background: Non-reflective aluminum with enameled scale markings graduated in both degrees F and degrees C.

F. Scale range: Temperature ranges for services listed as follows:

1. Heating Hot Water: 30ºF to 240ºF, with 2-degree scale divisions

2. Chilled Water: 0ºF to 100ºF, with 2-degree scale divisions.

G. Window: Glass, acrylic, or Lexan.

H. Stem: Stainless steel for separable socket, and of length to suit installation.

1. Design for Thermowell Installation: Bare stem.

I. Connector: 1¼ inches (32 mm), with ASME B1.1 screw threads.

J. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 THERMOWELLS

A. Standard: ASME B40.200.

B. Description: Pressure-tight, socket-type fitting with protective dry well made for insertion into piping threaded tee fitting.

C. Material for Use with Copper Tubing: Brass.

D. Material for Use with Steel Piping: Stainless steel.

E. Type: Stepped shank unless straight or tapered shank is indicated.

F. External Threads: NPS ½, NPS ¾, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.

G. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.

H. Bore: Diameter required to match thermometer bulb or stem.

I. Insertion Length: Length required to match thermometer bulb or stem, to extend to center of pipe.

J. Lagging Extension: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.

K. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

L. Cap: Threaded, with chain permanently fastened to socket.

M. Heat-Transfer Medium: Oil, conductive jelly, or mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Description: ASME B40.1, Grade A phosphor-bronze Bourdon-tube pressure gage with bottom connection; dry type, unless liquid-filled-case type is indicated.

1. Pressure gages serving pump differential measurement shall be liquid-filled.

B. Case: Drawn steel, brass, or aluminum with 4½-inch diameter glass lens.

C. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

D. Pressure Connection: Brass, with NPS ¼ (DN 8), ASME B1.20.1 pipe threads.

E. Movement: Mechanical, with link to pressure element and connection to pointer.

F. Dial: Non-reflective aluminum with enameled scale markings graduated in dual units of psi and kPa.

G. Pointer: Dark-colored metal.

H. Window: Glass, acrylic, or Lexan lens.

I. Ring: Brass or Stainless steel.

J. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

K. Range: Comply with the following:

1. Fluids under Pressure: Two times the operating pressure.

L. Gage Attachments:

1. Snubbers: ASME B40.100, brass; with NPS ¼ (DN 8), ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device of material suitable for system fluid and working pressure. Include extension for use on insulated piping.

2. Siphons: Loop-shaped section of brass or stainless-steel pipe with NPS ¼ (DN 8) pipe threads.

3. Valves: Brass or stainless-steel needle-type, with NPS ¼ (DN 8), ASME B1.20.1 pipe threads. Ball valves are not acceptable.

2.5 TEST PLUGS

A. Description: Test-station fitting made for insertion into piping tee fitting.

B. Body: Brass or stainless steel with core inserts. Include extended stem on units to be installed in insulated piping, with length as required to extend beyond insulation

C. Test-Plug Cap: Gasketed and threaded cap, with retention chain.

D. Thread Size: NPS ½ (DN 15), ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200ºF (3450 kPa at 93 C).

F. Core Inserts: Two (2) EPDM self-sealing rubber valve types, suitable for inserting a 1/8 inch outside diameter probe from a dial thermometer or pressure gage.

G. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

1. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125ºF (minus 4 to plus 52 C).

2. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220ºF (minus 18 to plus 104 C).

3. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).

4. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids (except steam).

H. Install valve and siphon fitting in piping for each pressure gage for steam.

I. Install test plugs in piping tees where indicated, located on pipe at most readable position. Secure cap.

J. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic coil in air-handling units.

2. Two inlets and two outlets of each hydronic heat exchanger.

K. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.

2. Multiple points at each pump as detailed on Drawings; include trumpet valve. Pressure gages serving pump differential measurement shall be liquid-filled and shall include snubber.

3. Where indicated on Drawings.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 230519

SECTION 230523 – VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 200800 “Seismic Protection,” Section 230100 “Basic Mechanical Requirements” and Section 230500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes the following general-duty valves common to several mechanical piping systems.

1. Ball valves.
2. Butterfly valves.
3. Check valves.
4. Globe valves.
5. Chainwheel actuators.

B. Related Sections include the following:

1. Division 23 Section “Mechanical Identification” for valve tags and charts.
2. Division 23 Section “Basic Mechanical Materials and Methods” for valve tags and charts.
3. Division 23 Section “Control Systems” for control valves and actuators.
4. Division 23 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves used in this Section:

1. CWP: Cold working pressure (formerly WOG – Water, Oil, Gas working pressure).
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. IBBM: Iron body, bronze-mounted.
4. OS&Y: Outside screw and yoke
5. PTFE: Polytetrafluoroethylene plastic.

6. SWP: Steam working pressure.

7. TFE: Tetrafluoroethylene plastic.

8. Class 125: Minimum 125-psig (860-kPa) SWP and minimum 200-psig (1380-kPa) CWP ratings.

9. Class 150: Minimum 150-psig (1035-kPa) SWP and minimum 300-psig (2070-kPa) CWP ratings.

1.4 SUBMITTALS

A. General: Follow the procedures specified in Division 01 Section “Special Conditions.”

B. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; furnished specialties; and accessories.

C. Maintenance Data: For each type of valve, to include in the operation and maintenance manual specified in Division 01. Include detailed manufacturer’s instructions on adjusting, servicing, disassembling, and repairing.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. MSS Compliance: Comply with the various MSS Standard Practice documents referenced herein.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set gate, and globe valves closed to prevent rattling.

4. Set ball valves open to minimize exposure of functional surfaces.

5. Set butterfly valves closed or slightly open.

6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General: Subject to compliance with requirements, globe valves, and swing check valves by one of the following:

1. Crane Co.; Crane Valve Group; Crane, Jenkins, & Stockham brands.
2. Grinnell Corporation.
3. Hammond Valve.
4. Milwaukee Valve Company.
5. NIBCO Inc.
6. Watts Industries, Inc.; Water Products Div.

B. Ball Valves: Subject to compliance with requirements, provide ball valves by one of the following:

1. Any of the manufacturers listed under the “General” subheading above.
2. Conbraco Industries, Inc.; Apollo Div.
3. Johnson Control Inc.
4. Griswold Controls.

C. Standard-Performance Butterfly Valves: Subject to compliance with requirements, provide butterfly valves by one of the following:

1. Any of the manufacturers listed under the “General” subheading above.
2. Bray International, Inc.
3. Crane Co.; Crane Valve Group; Center Line brand.
4. General Signal; DeZurik Unit
5. McWane, Inc.; Kennedy Div.
6. Metraflex Co.
7. Victaulic Co. of America.

D. Wafer and Lift-Disc Check Valves: Subject to compliance with requirements, provide butterfly-style dual-plate wafer check valves and piston-style lift-disc check valves by one of the following:

1. Any of the manufacturers listed under the “General” subheading above.

2. Metraflex Co.

2.2 VALVES, COMMON REQUIREMENTS

A. General: Refer to Part 3 “Valve Applications Schedule” Article for application schedule of valves, end connections, and actuator types.

B. Valve Sizes: Same as upstream pipe size, unless otherwise indicated.

C. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

D. Valve Grooved Ends: AWWA C606.

E. Valve Threaded Ends: With threads according to ASME B1.20.1.

F. Valve Bypass and Drain Connections: MSS SP-45.

G. Material Substitution: Ductile iron is acceptable anywhere cast iron is specified, but cast iron is not acceptable where ductile iron is specified.

H. Class Substitution: If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

I. Chainwheel Operators: Where required, provide valve actuation assembly with ductile iron sprocket rim, brackets, and hot-dip galvanized steel chain; of type, number, size and fasteners as required for the host valve.

J. For piping systems required to be insulated, valve stems shall be extended to accommodate insulation. Refer to other Division 23 Sections for piping systems required to be insulated.

2.3 BALL VALVES

A. Liquid Service, Size NPS 2 (DN 50) and smaller:

1. General: Valve shall conform to MSS SP-110.

2. Minimum SWP rating: 150-psig (1035-kPa).

3. Minimum CWP rating: 600-psig (4140-kPa).

4. Body: ASTM B584 bronze, two-piece construction.

5. Ball: Type 316 stainless steel, full port for NPS 1 (DN 25) and smaller, regular port otherwise.

6. Stem: Blowout-proof Type 316 stainless steel.

7. Seat/Packing: PTFE or TFE.

8. Ends: Threaded.

9. Handle: Vinyl-covered steel lever with memory stop; and zinc-plated steel nut.

2.4 STANDARD-PERFORMANCE BUTTERFLY VALVES

A. General: Valve shall conform to MSS SP-67, Type I.

B. Minimum CWP rating: 200-psig (1379-kPa).

C. Body and bonnet: Cast Iron ASTM A126 Class B.

D. Packing: Field-replaceable EPDM sleeve and stem seals.

E. Stem and Stem Hardware: 416 stainless steel and TFE bushing.

F. Disc: Aluminum bronze.

G. End Connections: Lug and flanged bodies are acceptable; wafer bodies are not acceptable. Grooved-end valve bodies are acceptable wherever grooved-end piping is permitted; refer to other Division 23 Sections for permitted applications of grooved-end piping.

H. Dead End Service: All butterfly valves shall be suitable for bi-directional dead-end service without downstream blind flange. Bolt holes on lugged valve bodies shall be threaded per ANSI B-1.1 coarse thread, with center stop, to accept cap screws from both directions.

I. Operator: Lever handle with ten-position latching mechanism, except where noted below.

1. Chainwheel Operators: Required for butterfly valves larger than NPS 4 (DN 100), if installed 96 inches (2400 mm) or higher above finished floor elevation.

2. Gear Drive: Required for butterfly valves NPS 6 (DN 150) and larger, and for any butterfly valves larger than NPS 4 (DN 100) if installed 96 inches (2400 mm) or higher above finished floor elevation, to accommodate a chainwheel operator.

2.5 CHECK VALVES

A. Bronze Swing Check Valve, NPS 2 (DN50) and smaller: Valve shall conform to MSS SP-80.

1. Minimum pressure rating: Class 150.

2. Body: ASTM B62 bronze body, y-pattern.

3. Bonnet: ASTM B62 bronze, threaded, removable for regrinding.

4. Disc and seat: Renewable; ASTM B62 bronze with bronze-alloy hinge pin.

5. Hardware: Bronze or bronze alloy.

6. Ends: Threaded.

B. Cast-Iron Swing Check Valves, NPS 2½ (DN65) and larger: Valve shall conform to MSS SP-71, Type I.

1. Minimum pressure rating: Class 125.

2. Minimum CWP rating: 200-psig (1379-kPa).

3. Body: ASTM A126 Cl. B cast-iron body.

4. Bonnet: ASTM A126 Cl. B cast-iron, bolted to body with steel bolts.

5. Disc and seat: Renewable; Ductile-iron or bronze-alloy.

6. Ends: Flanged.

C. Wafer Silent Check Valves, NPS 2½ (DN65) and larger: Valve shall conform to API 594.

1. Minimum pressure rating: Class 125.

2. Body: ASTM A126 Cl. B cast-iron.

3. Discs: Dual-plate aluminum bronze, spring-loaded, butterfly style.

4. Spring and hinge hardware: Type 316 stainless steel.

5. Ends: Wafer style, with diameter made to fit within bolt circle of adjacent flanges.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves as indicated, according to manufacturer's written instructions.

B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install isolation valves at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

D. Locate valves for easy access and provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above center of pipe.

F. Install valves in position to allow full stem movement.

G. Any valve that represents a termination or the end of a run (e.g., blowdown or drain valve, hose-end valve, etc.) shall be fitted with a permanent but removable cap, plug, or blind flange matching the valve construction, to minimize risk in the event the valve is accidentally opened under pressure.

H. Install chainwheel operators where specified. Extend chains to within 60 inches (1520 mm) above finished floor elevation.

I. Install check valves for proper direction of flow and as follows:

   1. Swing Check Valves: In horizontal position with hinge pin level, or vertical with upward flow.

   2. Dual-Plate Wafer Check Valves: In horizontal position, or vertical with upward flow.

3.3 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Threaded Connections: Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

   1. Align threads at point of assembly.

   2. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

   3. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

D. Flanged Connections: Align flange surfaces parallel.

   1. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

2. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.4 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.5 VALVE APPLICATIONS SCHEDULE

A. General: Refer to piping Sections and Drawings for specific valve applications. If no specific valve type is indicated, use the valve types indicated in the following schedules.

B. HVAC Chilled Water, Hydronic Heating Water Piping, HVAC Makeup Water and Drain Piping: Use the following types of valves. Choices are contractor's option unless a specific type of valve is specifically called out by name on the Drawings.

1. For shutoff duty, NPS 2 (DN 50) and smaller, use ball valves.

2. For shutoff duty, NPS 2½ (DN 65) and larger, use butterfly valves.

3. For throttling duty, NPS 2 (DN 50) and smaller, use ball valves or globe valves.

4. For throttling duty, NPS 2½ (DN 65) and larger, use butterfly valves or globe valves.

5. For pump discharge protection, NPS 2 (DN 50) and smaller, use swing check valves.

6. For pump discharge protection, NPS 2½ (DN 65) and larger, use wafer check valves.

7. For one-way flow control other than at pump discharge, use swing check valves in all sizes.

END OF SECTION 230523

SECTION 230529 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 20 0800 “Seismic Protection,” Section 230100 “Basic Mechanical Requirements”, Section 230500 “Basic Mechanical Materials and Methods” and Section 230540 “Mechanical Vibration Isolation” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes hangers and supports for mechanical system piping and equipment, including but not limited to the following:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections include the following:

1. Division 05 Section “Metal Fabrications” for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 20 Section “Seismic Protection” for seismic restraint requirements.
3. Division 23 Section “Pipe Expansion Fittings” for pipe guides and anchors.
4. Division 23 Section “Mechanical Vibration Isolation” for vibration isolation devices.
5. Division 23 Section “Metal Ducts” for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, “Guidelines on Terminology for Pipe Hangers and Supports.”

1.4 PERFORMANCE REQUIREMENTS

A. If contractor elects to apply channel support systems and/or heavy-duty steel trapezes to support multiple pipes, in lieu of individual supports, then contractor is responsible for design of same capable of supporting combined weight of supported systems, system contents, and test water.

   1. Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Do not suspend pipe hangers and supports from roof deck. Suspend such loads from structural steel only, and provide structural steel sub-framing as required.

D. Do not suspend piping loads exceeding 500 pounds within any 100 square feet of contiguous area from supported concrete floor slabs. Suspend such loads from structural members only, and provide structural steel sub-framing as required.

E. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1.5 SUBMITTALS

A. Product Data: For each type of pipe hanger and channel support system component indicated. Include:

   1. Metal pipe hangers and supports.

   2. Trapeze pipe hangers. Include Product Data for components.

   3. Metal framing systems. Include Product Data for components.

   4. Manufacturer paint color chart for Architect to pick color for all equipment installed in exposed spaces.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, “Structural Welding Code – Steel.”

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX, “Welding and Brazing Qualifications.”

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Manufactured Pipe Hangers:

    a. Anvil International, Inc.
    b. Cooper B-Line, Inc.
    c. Carpenter & Patterson, Inc.
    d. Erico International Corp.
    e. PHD Manufacturing, Inc.
    f. Tolco division of Cooper B-Line, Inc.

2. Metal Framing Systems:

    a. Anvil International, Inc.
    b. Cooper B-Line, Inc.
    c. Erico / Michigan Hanger Co.
    d. Thomas & Betts Corporation.
    e. Tolco division of Cooper B-Line, Inc.
    f. Unistrut Corporation; Tyco International, Ltd.

3. Thermal-Hanger Shield Inserts:

    a. Carpenter & Paterson, Inc.
    b. Erico International Corp.
    c. PHS Industries, Inc.
    d. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

4. Powder-Actuated Fastener Systems:

    a. Hilti, Inc.
    b. ITW Ramset/Red Head.
    c. Simpson Manufacturing Co.; Strong-Tie Anchor Systems Div.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Application: Refer to “Hanger and Support Applications” Article in Part 3 for where to use specific hanger and support types.

B. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel unless noted otherwise.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel unless noted otherwise.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes, according to Standard MFMA-4.

B. Channels: Continuous slotted steel channel with inturned lips.

C. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

D. Hanger Rods: As specified for Metal Pipe Hangers and Supports above.

E. Coatings: Manufacturer's standard finish, unless otherwise noted. All exposed systems shall be provided with a Paint Coating. Paint color will be selected by Architect during shop drawing review.

1. Metallic Coating: Hot-dipped galvanized.

2. Paint Coating: Polyester Powder Finish

3. Plastic Coating: PVC.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Piping Below Ambient Temperature: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig) minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Piping At or Above Ambient Temperature: Water-repellent treated, ASTM C533, Type I calcium silicate with 100-psig ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2-inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural and Miscellaneous Steel: As specified in Division 23 Section “Basic Mechanical Materials and Methods.”

B. Grout: As specified in Division 23 Section “Basic Mechanical Materials and Methods.”

PART 3 - **EXECUTION**

3.1 HANGER AND SUPPORT SCHEDULE OF APPLICATIONS

A. Contractor shall provide Mechanical Framing Systems from beam to beam to maintain hanger support maximum span distances described below.

B. Comply with MSS SP-69 for pipe hanger and trapeze selections and applications that are not specified in this Section.

C. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

D. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

E. Use copper-plated pipe hangers and copper or stainless-steel attachments, or use nonmetallic coatings on attachments for electrolytic protection, where hangers are in direct contact with copper tubing.

F. Horizontal-Piping Hangers and Supports for the first three hangers/supports or the first 50-feet (whichever is greater) adjacent to Pumps: Use spring hangers and supports. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports shall include the following types:

1. Horizontal (MSS Type 54): Mounted horizontally.

2. Vertical (MSS Type 55): Mounted vertically.

3. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

4. Exception: Spring hangers are not required adjacent to inline pumps that are smaller than 5-horsepower. Use other types of hangers and supports as listed for service below.

G. Horizontal-Piping Hangers and Supports for individual, insulated pipe runs which are both 2½-inch diameter or larger and 20 feet or longer: Unless otherwise indicated, choose among the following types:

1. Single Pipe Rolls (MSS Type 41): For suspension of pipes from two rods.

2. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes from single rod.

3. Complete Pipe Rolls (MSS Type 44): Where vertical adjustment is not necessary.

4. Adjustable Pipe Roll and Base Units (MSS Type 46): For vertical and lateral adjustment.

5. Exception: Piping whose normal operating temperature is less than 150ºF (e.g., chilled water) may be supported with static hangers specified in the next paragraph.

H. Horizontal-Piping Hangers and Supports for individual pipe runs less than 20 feet long and all piping 2-inch diameter or smaller, regardless of length: Unless otherwise indicated, choose among the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1).

2. Yoke-Type Pipe Clamps (MSS Type 2): For pipes NPS 4 and larger.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3).

4. Steel Pipe Clamps (MSS Type 4).

I. Horizontal-Piping Hangers and Supports for individual uninsulated pipe runs of any size or length: Unless otherwise indicated, choose among the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1).

2. Yoke-Type Pipe Clamps (MSS Type 2): For pipes NPS 4 and larger.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3).

4. Steel Pipe Clamps (MSS Type 4).

5. Adjustable Steel Band Hangers (MSS Type 7): For pipes up to NPS 2 only.

6. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For pipes up to NPS 2 only.

7. U-Bolts (MSS Type 24).

J. Vertical-Piping Hangers and Supports for individual, insulated pipe runs which are both 2½-inch diameter or larger and 20 feet or longer: Use spring hangers and supports. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports shall include the following types:

1. Horizontal (MSS Type 54): Mounted horizontally.

2. Vertical (MSS Type 55): Mounted vertically.

3. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

K. Vertical-Piping Hangers and Supports for individual pipe runs less than 20 feet long and all piping 2-inch diameter or smaller, regardless of length: Unless otherwise indicated, choose among the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8).

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): Where longer ends are required.

L. Vertical-Piping Hangers and Supports for individual uninsulated pipe runs of any size or length: Unless otherwise indicated, choose among the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8).

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): Where longer ends are required.

M. Hanger-Rod Attachments: Unless otherwise indicated, choose among the following types:

1. Steel Turnbuckles (MSS Type 13).

2. Steel Clevises (MSS Type 14).

3. Malleable-Iron Sockets (MSS Type 16).

4. Steel Weldless Eye Nuts (MSS Type 17).

N. Building Attachments: Unless otherwise indicated, choose among the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to concrete ceiling.

2. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

3. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams.

4. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

5. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

a. Light (MSS Type 31): 750 lb.
b. Medium (MSS Type 32): 1500 lb.
c. Heavy (MSS Type 33): 3000 lb.

6. Side-Beam Brackets (MSS Type 34): For sides of steel beams.

7. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

3.2 HANGER AND SUPPORT MAXIMUM SPACING AND MINIMUM ROD SIZE

A. Install hangers and supports with the following maximum spacing and minimum rod sizes.

B. Flanged, Threaded, or Welded Steel Piping for any Liquid-service piping systems:

1. NPS ½: Maximum span, 5 feet; minimum rod size, 3/8-inch.
2. NPS ¾: Maximum span, 7 feet; minimum rod size, 3/8-inch.
3. NPS 1: Maximum span, 7 feet; minimum rod size, 3/8-inch.
4. NPS 1¼: Maximum span, 7 feet; minimum rod size, 3/8-inch.
5. NPS 1½: Maximum span, 9 feet; minimum rod size, 3/8-inch.
6. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8-inch.
7. NPS 2½: Maximum span, 11 feet; minimum rod size, 1/2-inch.
8. NPS 3: Maximum span, 12 feet; minimum rod size, 1/2-inch.
9. NPS 4: Maximum span, 14 feet; minimum rod size, 5/8-inch.
10. NPS 5: Maximum span, 17 feet; minimum rod size, 3/4-inch.
11. NPS 6: Maximum span, 17 feet; minimum rod size, 3/4-inch.
12. NPS 8: Maximum span, 19 feet; minimum rod size, 7/8-inch.
13. NPS 10: Maximum span, 20 feet; minimum rod size, 7/8-inch.

C. Drawn-Temper Copper Piping for any liquid-service piping systems:

1. NPS ½: Maximum span, 4 feet; minimum rod size, 3/8-inch.
2. NPS ¾: Maximum span, 5 feet; minimum rod size, 3/8-inch.
3. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8-inch.
4. NPS 1¼: Maximum span, 6feet; minimum rod size, 3/8-inch.
5. NPS 1½: Maximum span, 8 feet; minimum rod size, 3/8-inch.
6. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8-inch.
7. NPS 2½: Maximum span, 9 feet; minimum rod size, 1/2-inch.
8. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2-inch.
9. NPS 4: Maximum span, 12 feet; minimum rod size, 5/8-inch.

D. Flanged, Threaded, or Welded Steel Piping for Fuel Gas piping systems:

1. NPS ½: Maximum span, 5 feet; minimum rod size, 3/8-inch.
2. NPS ¾: Maximum span, 7 feet; minimum rod size, 3/8-inch.
3. NPS 1: Maximum span, 8 feet; minimum rod size, 3/8-inch.

4. NPS 1¼: Maximum span, 9feet; minimum rod size, 3/8-inch.

5. NPS 1½: Maximum span, 9 feet; minimum rod size, 3/8-inch.

6. NPS 2: Maximum span, 9 feet; minimum rod size, 3/8-inch.

7. NPS 2½: Maximum span, 10 feet; minimum rod size, 1/2-inch.

8. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2-inch.

9. NPS 4: Maximum span, 10 feet; minimum rod size, 5/8-inch.

E. CPVC and PVC Piping for Drainage piping systems:

1. NPS ½: Maximum span, 3 feet; minimum rod size, 3/8-inch.

2. NPS ¾: Maximum span, 3 feet; minimum rod size, 3/8-inch.

3. NPS 1: Maximum span, 3 feet; minimum rod size, 3/8-inch.

4. NPS 1¼: Maximum span, 4 feet; minimum rod size, 3/8-inch.

5. NPS 1½: Maximum span, 4 feet; minimum rod size, 3/8-inch.

6. NPS 2: Maximum span, 4 feet; minimum rod size, 3/8-inch.

7. NPS 2½: Maximum span, 4 feet; minimum rod size, 1/2-inch.

F. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

G. Rod diameters may be reduced one size for double-rod hangers, with 3/8-inch (10 mm) minimum rods.

H. Hanger and support spacing for piping and tubing not listed above shall be according to MSS SP-69 and piping manufacturer's written instructions.

3.3 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2½and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Repair any building insulation or building fireproofing materials, whether new or existing, that are removed or scraped away in order to attach hangers and supports, so as to maintain an equivalent insulation or fire rating as existed without said hanger or support attachment.

L. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4-inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer’s operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer’s written instructions.

3.4 PROTECTION OF INSULATED PIPING:

A. Attach clamps and spacers to piping.

1. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

2. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

B. Do not exceed pipe stress limits according to ASME B31.9.

C. Piping Operating above Ambient Air Temperature: Clevis- and clamp-type supports may project through insulation.

1. Option: Thermal-hanger shield inserts may be used. Insert shall be same thickness as adjoining pipe insulation and length shall be at least as long as the protective shield. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

2. For piping on roller-type supports, install MSS SP-58, Type 39 protection saddles, and fill interior voids with insulation that matches adjoining insulation.

3. For pipes NPS 8 and larger, include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

D. Piping Operating below Ambient Air Temperature: Clevis- and clamp-type supports shall be sized for the outside diameter of the insulation including jacket. Install MSS SP-58, Type 40 protective shields. Shields shall span an arc of 180 degrees.

1. Pipe Sizes NPS 4 and larger: Include thermal-hanger shield inserts. Insert shall be same thickness as adjoining pipe insulation and length shall be at least as long as the protective shield. Include steel weight-distribution plate if pipe is installed on rollers.

E. Shield Dimensions for Pipe: Not less than the following:

1. NPS ¼ to NPS 3½: 12-inches long and 0.048-inch thick.

2. NPS 4: 12-inches long and 0.06-inch thick.

3. NPS 5 and NPS 6: 18-inches long and 0.06-inch thick.

4. NPS 8 to NPS 14: 24-inches long and 0.075-inch thick.

3.5 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.6 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and/or equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.7 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1½-inches.

3.8 PAINTING

A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grooved Couplings for motion control

B. Related Requirements:

1.2 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment.

PART 2 - PRODUCTS

2.1 Manufactures:

1. Victaulic
2. Groovelock
3. Mason Industries

2.2 PERFORMANCE:

A. Grooved joints for grooved couplings and fittings shall be in accordance with accepted manufacturer's specifications and practices.

B. Grooves may be cut or rolled in accordance with manufacturer's recommendations for type of pipe, sizes and thicknesses specified for respective systems.

C. Gaskets shall be suitable for the temperature, pressure and compatibility with the fluid contained therein. Unless specifically specified otherwise or incompatibility with the system, gaskets shall be EPDM grade E.

D. Grooved couplings shall be ASTM-A47 grooved malleable iron clamp type couplings as manufactured by Victaulic or equivalent.

E. Grooved couplings for vibration isolation or as unions at equipment connections shall be similar to Victaulic Style 77;

F. Grooved couplings are permitted for vibration isolation at rotating equipment. Grooved couplings are not permitted beyond this scope.

PART 3 - EXECUTION

3.1 APPLICATIONS

3.2 Steel piping connections to equipment with rotating or reciprocating components shall be provided with a minimum of two grooved clamp type couplings per piping connection, which shall be Victaulic Style 77 couplings or equivalent. Copper piping connections to equipment with rotating or reciprocating components shall be provided with Mason Industries SafetyFlex model SFDEJ flexible joint. Air handling units with internal fan isolation are not included in the above

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Brady Corporation.
    b. Carlton Industries, LP.
    c. Champion America.
    d. Craftmark Pipe Markers.
    e. Kolbi Pipe Marker Co.
    f. LEM Products Inc.
    g. Marking Services Inc.
    h. Pipemarker.com; Brimar Industries, Inc.
    i. Seton Identification Products; a Brady Corporation company.
    j. emedco.
2. Material and Thickness: anodized aluminum, 0.032-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for

greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Brady Corporation.
    b. Carlton Industries, LP.
    c. Champion America.
    d. Craftmark Pipe Markers.
    e. Kolbi Pipe Marker Co.
    f. LEM Products Inc.
    g. Marking Services Inc.
    h. Pipemarker.com; Brimar Industries, Inc.
    i. Seton Identification Products; a Brady Corporation company.
    j. emedco.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.
4. Craftmark Pipe Markers.
5. LEM Products Inc.
6. Marking Services Inc.
7. National Marker Company.
8. Pipemarker.com; Brimar Industries, Inc.
9. Seton Identification Products; a Brady Corporation company.
10. Stranco, Inc.

11. emedco.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-taping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA70E and other applicable codes and standards.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. Kolbi Pipe Marker Co.
7. LEM Products Inc.
8. Marking Services Inc.
9. Pipemarker.com; Brimar Industries, Inc.
10. Seton Identification Products; a Brady Corporation company.
11. emedco.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of mechanical equipment.

B. Sign and Label Colors:

1. White letters on an ANSI Z535.1 safety-blue background.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.4 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Match existing pipe color scheme in plant.

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.

D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

E. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

F. Pipe-Label Color Schedule:
1. Heating Water Piping: White letters on an ANSI Z535.1 safety-green background.
2. Low-Pressure Steam Piping: Black letters on an ANSI Z535.1 safety-yellow background.
3. Steam Condensate Piping: Black letters on an ANSI Z535.1 safety-yellow background.
4. Chilled Water: White letters on an ANSI Z535.1 safety-green background.

END OF SECTION 230553

SECTION 230566 - ANTIMICROBIAL ULTRAVIOLET LAMP SYSTEMS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. UV-C lamp systems for packaged air-handling units.
2. Controls.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each UV-C lamp system.

1. Include plans, elevations, sections, mounting, and attachment details.
2. Include details of UV-C lamp system assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Elevations and sections, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. Contractor's Construction Schedule.

C. Application for Payment and schedule of values.

D. Product Certificates: For each type of UV lamp, fixture, and system.

E. Product test reports.

F. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period, System: Five years from date of Substantial Completion.

2. Warranty Period, Lamp: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE Compliance:

1. Test UV-C lamp systems according to ASHRAE 185.1, "Method of Testing UV-C Lights for Use in Air-Handling Units or Air Ducts to Inactivate Airborne Microorganisms."
2. Test UV-C lamp systems according to ASHRAE 185.2, "Method of Testing Ultraviolet Lamps for Use in HVAC&R Units or Air Ducts on Irradiated Surfaces."

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Steril-Aire, Inc.
2. UV Resources.
3. Ultravation, Inc.

2.3 ANTIMICROBIAL UV-C LAMP SYSTEMS FOR PACKAGED AIR-HANDLING UNITS

A. Description: Factory-assembled UV-C lamp system with power supply housing, four each, 1/2- or 3/4-inch electrical knock-outs, power supply with integrated lamp plug, lamp compression nut, and UV lamp.

B. Power Supply: UL listed, single phase, 277 AC, 50 or 60 Hz, with a programmed rapid start.

1. Power Factor: High power factor, Class P, Sound Rated A, Type 1 Outdoor, and with inherent thermal protection and without polychlorinated biphenyl.
2. Output: Automatically sense and maximize lamp output, energy efficiency, and reliability for lamp lengths from 17 to 61 inches.
3. Operating Temperature: From 34 to 194 deg F.
4. Safety: Integral interlock switch on power supply.
5. Power Consumption: Maximum 15 W/sq. ft..
6. Electrical Connection: Single electrical connection with service disconnect.

C. UV-C Lamps: Encapsulated lamps with lamp wattage and model number visibly printed on all lamps, less than 8 Mg of mercury in each lamp. Lamps do not produce ozone.

1. Quantity and Type: T5, hot cathode, single-ended, four pin - See schedule for lamp size and quanity.
2. Output: UV-C energy, primarily at 253.7-nm wavelength with a 360-degree energy distribution.

3. Base: Long-mount base lamp. Lamp filament extends into the airstream beyond plenum walls and insulation.
4. Operating Temperature: From 34 to 158 deg F, 100-percent relative humidity, at any velocity.
5. Lamp Protection: Hermetically sealed with a thin layer of UV-C-transmissible fluorinated ethylene propylene to provide protection against lamp breakage and to ensure lamp contents from a broken lamp are contained.
6. Lamp Life: Minimum of 9000 hours with greater than 85 percent of initial output at end of lamp life.

D. Power Supply Housing: High-performance, white polycarbonate for external thermal rejection, equipped with lamp support for lamp lengths up to 61 inches and a weathertight cover with an integrated seal. Housing contains all components in one integral assembly for safety and serviceability without tools.

1. Interlock: Disrupt lever on the cover actuates the interlock switch to disconnect or restore power when removed or installed. Padlock eyelets lock the housing cover to guard against unwanted entry.
2. Surface Installation Mounting: Four mounting holes and gasket to seal housing to the mounting surface.

E. Lamp Holder and Lamp Clamp: Four-pin type accommodates a single-ended lamp.

1. Lamp Holder Construction: UV-resistant materials and designed to connect the lamp to the plug.
2. Lamp Clamp Construction: UV-resistant materials to ensure a watertight connection. A seal between the single-ended UV lamp and the lamp plug prevents electrical shock, connection shorts, and lamp or power supply failure, from lamp pin oxidation or arcing.

2.4 CONTROLS

A. Operating Control: Monitor lamp and power supply combination. UV-C lamp system operates continuously. Interlock UV-C lamp system operation with air-handling unit and component access doors. When an access door is opened, UV-C lamp system is de-energized.

PART 3 - EXECUTION

3.1 INSTALLATION OF ANTIMICROBIAL UV-C LAMP SYSTEMS FOR LARGE AIR-HANDLING UNITS

A. Install UV-C lamp systems according to manufacturer's installation manual and drawings unless otherwise indicated.

B. Install UV lamps in each UV-C lamp system.

C. Install UV-C lamp systems in locations that are accessible and that will permit servicing and maintenance.

D. Provide sufficient length of wiring loom to facilitate lamp connection to a remotely located power supply and/or power supply housing, such that lamp and loom can be mounted anywhere in the system.

E. Seal air-handling unit penetrations to maintain integrity of air-handling unit casings.

F. Irradiation: Quantity of UV lamps are to be installed to provide an equal distribution of available UV-C energy. When installed, UV-C energy produced shall be of the lowest possible reflected and shadowed losses, distributed in a 360-degree pattern within the cavity or plenum space.

G. Intensity: UV-C lamp system modeling shall be included in the submittal and must contain necessary calculations to demonstrate a minimum of 4 W/sq. ft. of coil surface area to achieve a minimum of 100 microwatts/sq. cm equally distributed on the target surface as recommended by ASHRAE.

H. Housing Installation: Power supply housing can be installed inside or outside air-handling units or plenums.

I. UV Lamp Installation: Mount UV lamp to irradiate surfaces, as well as the available line of sight airstream, through proper lamp placement, and incident angle reflection.

J. Safety: Comply with requirements in UL 1995, "Standard of Safety for Heating and Cooling Equipment." Provide mechanical interlock switch on access panels and doors to UV lamp systems, or within view of UV lamp systems, to ensure that UV-C lamp systems will be de-energized when these accesses are opened. Warning signs and labels are specified in Section 230553 "Identification for HVAC Piping and Equipment."

K. Signage: Comply with requirements in UL 1995 "Heating and Cooling Equipment." Mark access panels and doors to UV-C lamp systems with warning signs stating, "WARNING: UV LIGHT SOURCE" and "DISCONNECT POWER BEFORE SERVICING." Warning signs and labels are specified in Section 230553 "Identification for HVAC Piping and Equipment."

L. Identify UV-C lamp systems with equipment labels. Comply with requirements for equipment labels specified in Section 230553 "Identification for HVAC Piping and Equipment."

M. After installation, adjust UV-C lamp systems and supports to maximize exposure to surfaces, before energizing system.

3.2 ELECTRIC CONNECTIONS

A. Provide electrical power and service disconnects to products requiring electrical connections.

B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

C. Comply with requirements for service disconnects in Section 262816 "Enclosed Switches and Circuit Breakers."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

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

C. Perform the following tests and inspections:

1. Operational Test: After installing UV-C lamp systems, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Safety Interlock: Confirm proper operation of safety interlock power switches on access panels and doors.

D. UV-C lamp systems and components will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 CLEANING

A. Wipe lamps clean using manufacturers' recommended cleaning methods and materials.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain UV-C lamp systems.

END OF SECTION 230566

SECTION 230593 – TESTING, ADJUSTING, AND BALANCING

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. Section 200800 “Seismic Protection,” Section 230100 “Basic Mechanical Requirements,” and Section 230500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.

2. Adjusting total HVAC systems to provide indicated quantities.

3. Measuring electrical performance of HVAC equipment.

4. Reporting results of the activities and procedures specified in this Section.

B. Related Sections include the following:

1. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment.

2. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. AMCA: Air Movement and Control Association.

C. NEBB: National Environmental Balancing Bureau.

D. SMACNA: Sheet Metal and Air Conditioning Contractors’ National Association.

1.4 SUBMITTALS

A. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

1.5 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.

B. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports.

C. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

D. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards or in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification" except where more stringent requirements are specified in this Section.

E. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

1.7 COORDINATION

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

B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine equipment performance data, including fan and pump curves.

D. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

E. Examine air-handling equipment to ensure clean filters have been installed.

F. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible.

G. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

A. Before beginning testing, adjusting and balancing, verify the following:

1. Permanent electrical power wiring is complete.

2. Hydronic systems are filled, clean, and free of air.

3. Automatic temperature-control systems are operational.

4. Equipment and duct access doors are securely closed.

5. Balance, smoke, and fire dampers are open.

6. Isolating and balancing valves are open and control valves are operational.

7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

8. Windows and doors can be closed so design conditions for system operations can be met.

3.3 TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" except where more stringent requirements are specified in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

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

D. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans: Plus or minus 5 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.

3. Heating-Water Flow Rate: Plus or minus 5 percent.

4. Cooling-Water Flow Rate: Plus or minus 5 percent.

E. For hydronic systems without field-adjustable balance valves (for example, systems that use automatic flow limiting valves, pressure-independent control valves, or reverse-return systems with no balance valves): The work of this Section includes measuring and verifying the water flow rates at each terminal even though balance valve adjustment may not be applicable.

3.4 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include pump curves and fan curves.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page.

2. Name and address of testing, adjusting, and balancing Agent.

3. Project name.

4. Project location.

5. Architect’s name and address.

6. Engineer’s name and address.

7. Contractor’s name and address.

8. Report date.

9. Signature of testing, adjusting, and balancing Agent who certifies the report.

10. Summary of contents, including design versus final performance, notable characteristics of systems, and description of system operation sequence if it varies from the Contract Documents.

11. Nomenclature sheets for each item of equipment.

12. Data for terminal units, including manufacturer, type size, and fittings.

13. Notes to explain why certain final data in the body of reports vary from design values.

14. Test conditions for fans and pump performance forms.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems with a keyed identification system for each device.

F. Air-Handling Unit Test Reports.

G. Apparatus-Coil Test Reports: For all air handling unit coils.

H. Fan Reports: For all supply, return, and exhaust fans.

I. Duct Traverse Reports.

J. Air-Terminal-Device Reports: For each terminal unit, air inlet, and air outlet.

K. System-Coil Reports: For all reheat coils and water coils of terminal units.

L. Variable Flow Hydronic Systems

M. Heat-Exchanger/Converter Reports.

N. Pump Reports.

O. Instrument Calibration Reports: For instrument calibration, include instrument type and make, serial number, application, dates of use, and dates of calibration.

END OF SECTION 230593

SECTION 230700 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 20 0800 “Seismic Protection,” Section 230100 “Basic Mechanical Requirements,” and Section 230500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes mechanical insulation for ductwork, equipment, piping, and other installations, including the following:

1. Insulation Materials:

    a. Glass, Fiber
    b. Flexible elastomeric.
    c. Fire Rated Insulation Systems

2. Fire-rated insulation systems.

3. Insulating cements.

4. Adhesives.

5. Mastics.

6. Sealants.

7. Factory-applied jackets.

8. Field-applied fabric-reinforcing mesh.

9. Field-applied jackets.

10. Tapes.

11. Securements.

12. Corner angles.

B. Related Sections include the following:

1. Division 23 Section “Metal Ducts” for internal duct liners.

1.3 DEFINITIONS

A. ASJ: All-service jacket.

B. FSK: Foil, scrim, kraft paper.

C. SSL: Self-sealing lap.

D. Thermal Resistivity: “R-values” represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1-inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one BTU to flow through one square foot of material, in one hour, at a given mean temperature.

E. Refer to Division 23 Section “Basic Mechanical Materials and Methods” for definitions of finished, interior, exterior, exposed, and concealed locations.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as determined by testing identical products per ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section “Hangers and Supports.”

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct installer for duct insulation application, and equipment installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Fiberglass Pipe Insulation: (GF1)

    a. Owens-Corning Calcium Silicate or equivalent from:
    b. Knauf
    c. Manville
    d. Pabco

2. Fiberglass Rigid Board (GF-2)
    a. Owens-Corning type ASJ with SSL-II vapor retarder jacket or equivalent from:
    b. CertainTeed
    c. Knauf
    d. Manville
    e. Schuller.

3. Fiberglass Flexible Blanket (GF-3)
    a. Owens-Corning type 100 All Service faced duct wrap or equivalent from:
    b. CertainTeed
    c. Knauf
    d. Manville
    e. Schuller

4. Flexible Elastomeric Insulation: (F1)

    a. Aeroflex USA Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.
    c. K-Flex USA; Insul-Lock® Seam-Seal.
    d. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

5. Insulating Cements: Same as insulation manufacturer, or

    a. Insulco, Division of MFS, Inc.
    b. P. K. Insulation Mfg. Co., Inc.
    c. Rock Wool Manufacturing Company.

6. Sealants, Adhesives and Mastics: Same as insulation manufacturer, or

a. Childers Products, Division of ITW.
b. Foster Products Corporation, H. B. Fuller Company.
c. ITW TACC, Division of Illinois Tool Works.
d. Marathon Industries, Inc.
e. Mon-Eco Industries, Inc.
f. Vimasco Corporation.

7. Field-Applied Jackets: Same as insulation manufacturer, or

a. Childers Products, Division of ITW.
b. P.I.C. Plastics, Inc.
c. PABCO Metals Corporation.
d. Pittsburgh Corning Corporation.
e. Polyguard.
f. Proto PVC Corporation.
g. RPR Products, Inc.
h. Speedline Corporation.

8. Tapes: Same as insulation manufacturer, or

a. Avery Dennison Corporation, Specialty Tapes Division.
b. Compac Corp.
c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Venture Tape.

9. Bands and Wire: Same as insulation manufacturer, or

a. ACS Industries, Inc.
b. C & F Wire.
c. Childers Products.
d. PABCO Metals Corporation.
e. RPR Products, Inc.

10. Insulation Pins and Hangers: Same as insulation manufacturer, or

a. AGM Industries, Inc.
b. GEMCO.
c. Midwest Fasteners, Inc.
d. Nelson Stud Welding.

11. Fire-Rated Insulation Systems:

a. 3M/Thermal Ceramics FireMaster® Duct Wrap.
b. Nelson Firestop Products FSB Flameshield Blanket
c. Premier Refractories Pyroscat® FP Duct Wrap
d. Fyre Wrap Elite Unifrax I LLC

2.2 INSULATION MATERIALS

A. Refer to Schedule in Part 3 for requirements about where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Adhesives shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

G. Fiberglass non-combustible, preformed for pipe and tube application, ANSI/ASTM C547, Class 1

1. “k” value of 0.23 at 75 degrees F.

2. ASJ with SSL-II Vapor Retarder

H. Fiberglass non-combustible, rigid board with vapor retarder facing, ANSI/ASTM C612

1. K value of .24 at 75 degrees F, 3lb/cubic foot density

2. ASJ 25 Jacket

I. Fiberglass fl exible blanket, laminated to reinforced draft vapor retarder facing ANSI/ASTM C553 Type II.

1. K value of .27 at 75 degrees F 1 lb/cubic foot density

J. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials and Type II for sheet materials.

1. Thermal Conductivity: 0.28 average maximum at 75ºF mean temperature.

2. Adhesive: Comply with MIL-A-24179A, Type II, Class I.

2.3 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700ºF. Comply with ASTM C656, Type II, Grade 6. UL tested and certified to provide a 2-hour fire rating.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating.

C. All products shall comply to ASTM E 2336 / AC 101 2-Hour Kitchen Exhaust Duct – Zero clearance at all points on ducts; ASTM E814 – Firestop: 2-Hour F&T Ratings; ASTM E 84/ UL 723 – Encapsulated: Flame < 25, Smoke <50; ASTM C 518 – R-Value: 7.2 per inch at 75 F; EN 1094 – Temperature Grade 2300 ºF; ASTM E 119 – 2-hour Engulfment; NFPA 96.

D. Lagging Adhesives: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.

2. Service Temperature Range: Minus 50 to plus 180ºF.

3. Color: White.

4. No VOC.

2.4 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449/C 449M.

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E96, Procedure B, 0.013 perm at 43-mil dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180ºF.

3. Solids Content: ASTM D1644, 59 percent by volume and 71 percent by weight.

4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F1249, 3 perms at 0.0625-inch dry film thickness.

2. Service Temperature Range: Minus 20 to plus 200ºF.

3. Solids Content: 63 percent by volume and 73 percent by weight.

4. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Permanently flexible, elastomeric sealant.

3. Service Temperature Range: Minus 100 to plus 300ºF.

4. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.

3. Service Temperature Range: Minus 40 to plus 250ºF.

4. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.

3. Service Temperature Range: Minus 40 to plus 250ºF.

4. Color: White.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: Compatible with PVC, as recommended by jacket material manufacturer.

2. Color: White (In exposed areas and noted on Drawings Architect shall pick color during shop drawing review from manufacturer's color chart.)

3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

4. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jackets: Sheet and roll stock ready for shop or field sizing. Factory pre-cut and rolled to size is also acceptable. Material, finish, and thickness are indicated in field-applied jacket schedules.

1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

2. Stainless-Steel Jacket: ASTM A167 or ASTM A240.

3. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.

4. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

5. Factory-Fabricated Fitting Covers: Same material, finish, and thickness as jacket; provide as required for preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows, tee covers, flange and union covers, end caps, beveled collars, and valve covers.

6. Field-fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136 and UL listed.

1. Width: 3-inches.

2. Thickness: 11.5 mils.

3. Adhesion: 90 ounces force/inch in width.

4. Elongation: 2 percent.

5. Tensile Strength: 40 lbf/inch in width.

6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

7. Maximum VOC limit of 50g/L.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136 and UL listed.

1. Width: 3-inches.

2. Thickness: 6.5 mils.

3. Adhesion: 90 ounces force/inch in width.

4. Elongation: 2 percent.

5. Tensile Strength: 40 lbf/inch in width.

6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

7. Maximum VOC limit of 50g/L.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Width: 2-inches.

2. Thickness: 6 mils.

3. Adhesion: 64 ounces force/inch in width.

4. Elongation: 500 percent.

5. Tensile Strength: 18 lbf/inch in width.

6. Maximum VOC limit of 50g/L.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.

1. Width: 2-inches.

2. Thickness: 3.7 mils.

3. Adhesion: 100 ounces force/inch in width.

4. Elongation: 5 percent.

5. Tensile Strength: 34 lbf/inch in width.

6. Maximum VOC limit of 50g/L.

2.9 SECUREMENTS

A. Bands:

1. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch thick, ½-inch wide with wing or closed seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1½-inch galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Baseplate shall be perforated, galvanized carbon-steel sheet, 0.030-inch thick by 2-inches square. Spindle shall be copper, aluminum, or stainless steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated. Adhesive shall be as recommended by hanger manufacturer; with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Self-Sticking-Base Insulation Hangers: Adhesive-backed base with a peel-off protective cover; and baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Baseplate shall be galvanized carbon-steel sheet, 0.030-inch thick by 2-inches square. Spindle shall be copper, aluminum, or stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, aluminum or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1½-inches in diameter. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

2.10 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1-inch, PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040-inch thick, minimum 1 by 1-inch, aluminum according to ASTM B209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 COMMON INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4-inches o.c.

3. Overlap jacket longitudinal seams at least 1½-inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2-inches o.c.

4. For below ambient services, apply vapor-barrier mastic over staples.

5. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4-inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. At the following locations, omit jacket and provide a separate cutaway removable segment of insulation clearly labeled “Access.” For below-ambient services, provide a design that allows access but maintains vapor barrier.

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2-inches below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2-inches.

4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations:

1. Install pipe insulation continuously through pipe penetrations of fire-rated walls and partitions.

2. Install duct insulation continuously through duct penetrations of fire-rated walls and partitions, for cases where no fire or smoke damper is required.

3. Terminate duct insulation at fire or smoke damper sleeves for cases where fire or smoke dampers are used, but overlap duct insulation at least 2-inches.

4. Firestopping and fire-resistive joint sealers are specified in Division 07 Section "Penetration Firestopping."

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2-inches.

2. Pipe: Install insulation continuously through floor penetrations.

3. Seal penetrations through fire-rated assemblies according to Division 07 Section "Penetration Firestopping."

3.5 DUCT INSULATION INSTALLATION

A. Secure all insulation on ducts and plenums with insulation pins. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

1. On duct sides with dimensions 18-inches and smaller, pins may be omitted.

2. On duct sides with dimensions 18-inches and larger, place pins along longitudinal centerline of duct. Space 3-inches maximum from insulation end joints, and 16-inches o.c.

3. On duct sides with dimensions larger than 36-inches, place pins 16-inches o.c. each way, and 3-inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

4. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

5. Do not overcompress insulation during installation.

6. If using blanket insulation, impale insulation over pins and attach speed washers.

7. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

B. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2-inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with ½-inch (13-mm) outward-clinching staples, 1-inch (25 mm) o.c.

Complete the vapor barrier by applying FSK tape specified in Part 2, or vapor-barrier mastic and sealant, at all joints, seams, and protrusions.

1. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

2. Install vapor stops for ductwork and plenums operating below 50ºF (10 C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3-inches (75 mm).

C. If using blanket insulation, overlap unfaced blankets a minimum of 2-inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18-inches o.c.

D. Unless factory-insulated, install duct insulation continuously and unbroken over duct-mounted accessories such as fans, coils, terminal units, etc.

E. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. If using board insulation, groove and score insulation to fit as closely as possible to outside and inside radius of elbows.

F. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

G. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6-inches o.c.

H. Install corner angles on external corners of insulation on insulated ductwork in exposed mechanical or finished spaces before covering with jacketing.

I. At connections to equipment such as VAV boxes, fan coil units, all collars, reheat coils, coil return bends shall be insulated as the adjacent duct. All components in contact with 55

3.6 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Where required, secure blanket or board insulation to equipment, tanks and vessels with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of tank and vessel surfaces.

2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

3. Protect exposed corners with secured corner angles.

4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels. Do not weld anchor pins to ASME-labeled pressure vessels. Select insulation hangers and adhesive that are compatible with service temperature and with substrate. On tanks and vessels, maximum anchor-pin spacing is 3-inches from insulation end joints, and 16-inches o.c. in both directions. Do not over-compress insulation during installation. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels. Impale insulation over anchor pins and attach speed washers. Cut excess

portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6-inches from each end. Install wire or cable between two circumferential girdles 12-inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch pre-stressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48-inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3-inches.

8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.

2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

2. Fabricate boxes from aluminum or stainless steel, at least 0.040-inch thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.7 PIPE INSULATION INSTALLATION

A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. If furnished in half sections, orient longitudinal joints at 3 and 9 o'clock positions on the pipe.

2. All insulation shall be tightly butted and free of voids and gaps at all joints.

3. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

4. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6-inches o.c.

5. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant. Vapor barrier must be continuous.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation, not to exceed 1½-inch thickness.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same thickness as pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1-inch, and seal joints with flashing sealant.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

3. Cut sectional pipe insulation to fit. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

E. Insulation Installation on Valves, Strainers, Unions, and Specials:

1. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation over valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

4. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

5. Insulate unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

7. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

8. Stencil or label the outside insulation jacket of each union with the word “UNION.” Match size and color of pipe labels.

F. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

G. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2-inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

H. Special Requirements for Flexible Elastomeric Insulation Installation: Seal all transverse seams, longitudinal seams, end joints, and section joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12-inches o.c. and at end joints.

3.9 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

2. Finish Coat Material: Interior, flat, latex-emulsion size.

C. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

D. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

E. Do not field paint aluminum or stainless-steel jackets.

3.10 DUCT AND PLENUM INSULATION SCHEDULE

A. Plenums and Ducts Requiring Insulation: 1-1/2” 1.5 lb/cu.ft. foil faced duct blanket.

1. Indoor supply and outdoor air ducts:

2. Indoor return air ducts if located in non-conditioned space:

   a. The space above a ceiling is considered conditioned space if the space below that ceiling is conditioned space.
   b. A vertical shaft is considered conditioned space if the spaces on all sides surrounding the shaft are conditioned spaces.

3. Supply ductwork downstream of all air terminal units.

4. Indoor, exposed and concealed all damper handles on plenums and ducts requiring insulation included on this list.

B. Items Not Insulated:

1. Metal ducts with internal duct liner, unless noted to be insulated.

2. Factory-insulated flexible ducts.

3. Factory-insulated plenums and casings.

4. Flexible connectors.

5. Factory-insulated access panels and doors.

3.11 DUCT AND PLENUM INSULATION DETAILS

A. Where insulation is required via the Duct and Plenum Insulation Schedule above, insulation for indoor concealed rectangular and round ducts and plenums shall be Mineral-Fiber blanket, thick enough to achieve an installed R-value of 3.5 but not less than 1½-inches thick; and 1.5-lb/cu. ft. nominal density.

B. Where insulation is required via the Duct and Plenum Insulation Schedule above, insulation for indoor exposed round ducts and plenums shall be Mineral-Fiber blanket, thick enough to achieve an installed R-value of 3.5 but not less than 1½-inches thick; and 1.5-lb/cu. ft. nominal density.

C. Where insulation is required via the Duct and Plenum Insulation Schedule above, insulation for indoor exposed rectangular ducts and plenums shall be Mineral-Fiber board, thick enough to achieve an installed R-value of 3.5 but not less than 1½-inches thick; and 1.5-lb/cu. ft. nominal density.

D. Where insulation is required via the Duct and Plenum Insulation Schedule above, insulation for outdoor concealed rectangular, round and flat-oval ducts and plenums shall be Mineral-Fiber blanket, thick enough to achieve an installed R-value of 6.0 but not less than 2-inches thick; and 1.5-lb/cu. ft. nominal density.

E. Where insulation is required via the Duct and Plenum Insulation Schedule above, insulation for indoor exposed rectangular and round ducts specifically outside air supply, return and exhaust associated with energy recovery units located in attic space outside of mechanical rooms shall be the following:

1. Mineral-Fiber Blanket: Thick enough to achieve an installed R-value of 6.0 but not less than 2 inches thick; and 1.5-lb/cu. ft. nominal density.

F. Where insulation is required via the Duct and Plenum Insulation Schedule above, insulation for indoor concealed and exposed damper extended shafts and handles for rectangular and round ducts and plenums shall be the following:

1. Mineral-Fiber Blanket: Thick enough to achieve an installed R-value of 3.5 but not less than 1½-inches thick; and 1.5-lb/cu. ft. nominal density.

G. All ductwork associated with Kitchen Exhaust, Elevator Relief Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

3.12 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Chilled-water pump insulation shall be flexible elastomeric, 1-inch thick.

D. Heating-hot-water expansion tank insulation shall be any of the following:

1. GF2 Fiberglass 2-inch thick.

E. Chilled-water air-separator insulation shall be any of the following:

1. F2 Flexible Elastomeric: 1-inch thick.

F. Heating-hot-water air-separator insulation shall be any of the following:

1. Cellular Glass: 2-inches thick.

2. Mineral-Fiber Pipe and Tank: 2-inches thick.

G. Chilled Water and Glycol Heat Exchanger

1. F2 Flexible Elastomeric: 1-inch thick

H. Steam Heat Exchanger
1. 2” GF2 Fiberglass 2” thick

3.13 PIPING INSULATION SCHEDULE, GENERAL

A. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Fire-suppression piping.

2. Below-grade piping.

3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

4. Condensate piping between steam trap and union.

5. Unions, flanges, strainers, flexible connections, and expansion joints on hot piping.

B. Hot Surfaces: For piping services denoted as 140ºF or greater, all piping surfaces including but not limited to pipe, flanges, fittings, valves of every kind, strainers, unions, and other appurtenances shall be insulated to avoid potential for personnel injury via contact with hot surface.

C. Cold Surfaces: For piping surfaces operating below surrounding ambient temperature, all piping surfaces including but not limited to pipe, flanges, fittings, valves of every kind, strainers, unions, and other appurtenances shall be insulated and shall include uninterrupted vapor barrier to avoid potential condensation.

D. Provide removable covers and insulation on strainers and manual or automatic flow control valves.

3.14 PIPE INSULATION SCHEDULE, INDOORS

A. Condensate and Equipment Drain Water below 60ºF:

1. NPS 6 (DN 150) and Smaller: Insulation shall be either of the following:

a. Flexible Elastomeric: ¾-inch thick.

B. Chilled Water, above 40ºF:

1. NPS 5" and Smaller: Insulation shall be any of the following:

a. Flexible Elastomeric: 1-inch thick.

2. NPS 6" and Larger: Insulation shall be any of the following:

a. Polyisocyanurate 2#/cu.ft. 1½-inches thick with Saran 560 Barrier
b. Phenolic preformed 1-1/2" with Saran 560 Barrier

C. Heating-Hot-Water Supply and Return, 200ºF and below:

1. NPS 1¼ and Smaller: Insulation shall be Mineral-Fiber, Preformed Pipe, Type I, 1½-inches thick. For piping located in partitions within indoor conditioned spaces reduction of insulation thickness shall be permitted to 1-inch (25 mm) thick.

2. NPS 1½ and Larger: Insulation shall be Mineral-Fiber, Preformed Pipe, Type I, 2-inches thick.

D. Hot Service Drains, Blowdowns, and Vents: For all pipe sizes, insulation shall be Mineral-Fiber, Preformed Pipe, Type I, 1-inch thick.

E. Steam and Condensate Piping
1. GF2 Fiberglass 2" thick

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

Finish piping insulation with factory or field application for respective locations as follows:

Dry, low abuse: (indoor)	Concealed, not exposed to view. Mechanical equipment room. Exposed, finish space.
Pipe:	ASJ jacket.

Fittings:	Pre-molded PVC covers.
High abuse area:	Exposed vertical risers in all Storage Rooms, Janitor Closets. Exposed, unfinished space.
Pipe:	Stainless steel or aluminum jacket with seam away from abusive force. Apply to height of 8 feet.
Fittings:	Formed stainless steel covers.

END OF SECTION 230700

SECTION 230900 - CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Drawings and general provisions of Contract, including General and Special Conditions apply to work of this section.

B. Section 200800 “Seismic Protection”, Section 230100 “Basic Mechanical Requirements” and Section 230500 “Basic Mechanical Materials and Methods” apply to the work of this Section as if fully repeated herein.

1.2 REFERENCES

A. Work for this Section of the Specifications shall be performed in accordance with the Codes, Standards, etc. as identified in Division 20 in addition to the following:

B. N.E.C., NFPA 70 – 1996

C. FCC rules, Part 15, Subpart J, regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.

D. UL 916 Underwriters Laboratories Standard for Energy Management Equipment.

E. ASHRAE Standard 135-2016, BACnet – A Data Communication Protocol for Building Automation and Control Networks

1.3 SUMMARY

A. **DDC controllers shall be of C&C Controls No Exceptions**

B. This section contains requirements for electric and digital control systems as indicated on the contract drawings.

C. Contractor is responsible for providing, installing and connecting all DDC controllers, sensors, actuators, control valves, control dampers, electrical components and all interconnecting tubing and electrical wiring between these devices and up to the Direct Digital Controller (DDC).

D. After all equipment has been installed, wired and piped, Contractor will be responsible for all termination connections at the DDC controller’s and for checking, testing, programming and start-up of the control system.

E. By Phase, Once each mechanical system is completely operational under the new control system, contractor shall make any final connections and adjustments.

1.4 COORDINATION

A. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 28 Section “Digital, Addressable Fire Alarm System” to achieve compatibility with equipment that interfaces with that system.

C. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

D. Dedicated 20-amp / 120-volt AC Power circuit breakers are provided by Division 26 at Panel locations as shown on the Electrical Drawings. From that point, the party responsible for performance of this Section shall furnish, install, and connect all required power supply to all electric-powered control components furnished under this section. Furnish, install, and connect transformers as required to serve lower voltage and/or DC components furnished under this section. Perform field electrical work in complete and strict accordance with Division 26 requirements, the National Electric Code, and Part 3 of this Section.

E. Coordinate equipment with Division 26 Section “Panelboards” to achieve compatibility with starter coils and annunciation devices.

F. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section “Cast-in-Place Concrete.”

1.5 CONNECTIVITY

A. Controls associated with this project shall be connected to existing campus system. All components of the new controls system and any associated hardware for all systems specified interface seamlessly and are fully compatible with the existing BAS.

1.6 WORK INCLUDED

A. Furnish material, labor and services necessary for and reasonably incidental to the installation of the following work where shown on the Plans and as hereinafter specified. Include all necessary work in the related sections of the Specifications to perform the Work completely.

B. All engineering, labor, material, components, tubing, wiring, software, data base generation, graphics development, etc., as required for a complete operational control system as described on the drawings, in the specification, and as required by good practice.

C. Furnishing of sensor wells, calibration wells, valve bodies, control dampers, smoke dampers, air flow measuring stations, etc. for installation, by the respective trade contractors, under other sections of the specification.

D. Coordination as required with Divisions 26, 27 and 28 for proper interlocking, control wiring, and start-up. Furnish and supervise the installation of all control equipment required by Divisions 26, 27 and 28 for interlocks as indicated on the drawings and specified herein.

E. Coordination with other Divisions 20 - 29 sections as required to assure proper equipment interlocking and installation including, but not limited to, damper installations, mixing box arrangements, terminal unit controls, and adjustment required by the testing and balancing work.

F. Provide technicians to assist the balancer, and to adjust the economizer dampers to maintain design cfm during economizer modulation with no greater than a 10% variation.

1.7 WORK NOT INCLUDED

A. The following considerations are not included in the Scope of Work for the proposal for this Section of the Specifications:

B. Installation of sensor wells, calibration wells, valve bodies, control dampers, and smoke dampers furnished under this section of the specification for installation under other sections of the specification.

C. Power wiring and relays shown on the electrical drawings furnished and installed under Division 26.

1.8 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Automatic control dampers

B. Temperature sensor wells and sockets

C. Control Valves

1.9 SUBMITTALS

A. Schematic diagrams for each system, identifying by make and model number, size, capacity, performance, range, accuracy, etc., of each device. Each device shall have an identifying number unique to that device.

B. Detailed sequence of operation of each system or device including specific references to each of the components in the system describing specifically how the component affects system operation in the various operating modes. This detailed sequence shall be preceded by a generalized overview of the sequence describing in broad terms how the system functions.

C. Complete engineering data and descriptive literature for each component.

D. Complete wiring diagrams including: the system riser diagram showing the network architecture; floor diagrams showing sensor locations, panel locations, and equipment locations; point to point wiring diagrams for each electrical and electronic device showing all internal wiring and all interlock wiring required to complete the intent of the sequence of operations of the systems described in this section of the specifications.

E. Control panel layout drawings showing internal and external component arrangements, entry and exit points for wiring and tubing, and a list of all cover mounted labels indicating label size and inscription.

PART 2 - AIR SIDE CONTROL EQUIPMENT

2.1 AIR SIDE CONTROL EQUIPMENT TEMPERATURE MEASUREMENT

A. Outdoor Air Temperature Sensor:
   1. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD.
      a. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, ±1% at 25°C or ±0.36°F accuracy.
      b. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, ±1% at 25°C or ±0.36°F accuracy.

2. The housing shall be a NEMA 4 aluminum box with gasket cover or ABS enclosure that will accept water tight conduit connections. The sensor shall be integrally shielded from sunlight and weather with good ventilation for accurate readings, do not rely on building structure to provide shade. If sensor is not provided with integral sun shield, provide optional accessory to accommodate.
3. Acceptable sensors are Precon model ST-O, ACI model A/xx-O-BB(EH), BAPI model BA/10K(1K)-O-BB2, or approved equivalent.
4. Outdoor air sensor shall be located where shown on the drawings or in a place as directed by the Architect/Engineer. Location shall be accessible for annual routine maintenance of sensor for calibration or replacement.

B. Duct Temperature Sensor – For Air Handling Unit Systems:
1. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD.
    a. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, ±1% at 25°C or ±0.36°F accuracy.
    b. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, ±1% at 25°C or ±0.36°F accuracy.
2. The housing shall be a 4" x 2" galvanized steel utility box with cover or ABS enclosure that will accept conduit connections. The bottom of the housing shall have a foam gasket to seal the housing to the duct to minimize air leakage.
3. Acceptable sensors are Minco model S451PFY, Precon model ST-Dx-XH(P), ACI model A/10K(1K)- D-8-GD(BB), BAPI model BA/10K(1K)-D-8"-JB, or approved equivalent.
4. Sensor length shall be coordinated with ductwork; length shall be at least 6" beyond insulation or inner wall of duct.

C. Duct Temperature Sensor – For Terminal Unit Equipment:
1. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD.
2. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, ±1% at 25°C or ±0.36°F accuracy.
    a. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, ±1% at 25°C or ±0.36°F accuracy.
3. The sensor shall be provided without enclosure, but with mounting tabs, grommet seal, and integral plenum rated cable of sufficient length (5' minimum) that sensor terminations are made directly at the terminal unit controller without any splices between sensor and controller.
4. Acceptable sensors are Precon model KTVx-XCP5, Mamac model TE-701-BX-x-A, BAPI model BA/10K(1K)-D-4"-NB-5', or approved equivalent.
5. Sensor length shall be coordinated with ductwork; length shall be at least 4" beyond insulation or inner wall of duct.
6. Sensor shall be installed on a vertical duct face, at the midpoint of the duct to avoid stratification and mixing effects from the reheat coil. Sensors shall not be installed on the top or bottom of the duct without explicit direction or approval of the Engineer. Sensor shall be installed before the first air outlet tap from the distribution ductwork, but as far downstream as allowable by the integrated plenum cable.

D. Duct Temperature Bendable Averaging Elements
1. Sensor shall be bendable copper or aluminum sheath, continuous sensing 10,000 ohm Thermistor or 1,000 ohm RTD.
    a. The element shall be 10,000 ohm thermistor, with a reference temperature coefficient of resistance (TCR R25/125) compatible with the system installed, ±0.36°F accuracy.

b. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, ±1% at 25°C or ±0.36°F accuracy.

2. The housing shall be 4" x 2" galvanized steel utility box with cover or ABS enclosure that will accept conduit connections. The bottom of the housing shall have a foam gasket to seal the housing to the duct to minimize air leakage.

3. Sensor length shall provide coverage of 20' element per 25 square feet of installed area.

4. Acceptable sensors are Precon model ST-FZ, ACI Model A/xx-A-24-GD, BAPI model BA/10K-x-A24- JB, or approved equivalent.

5. Temperature sensing elements shall be strung in free air and shall not be supported from the face of the coil to prevent the temperature of the coil media from affecting the element reading. Where element is bent to turn in air stream, provide a manufactured insulated capillary mounting clip at each turn point. Capillary mounting clip shall be Klipet CC-1G-K, M-648-K copper clad mounting clip (only if element insulated from metal-to-metal contact with polyethylene tubing around element within capillary clip), or approved equivalent.

E. Low Limit Thermostat (Freezestat):

1. All low limit thermostat circuits shall have a manual reset function to restore normal system operation following correction of freeze condition. The manual reset function may be achieved with manual reset low limit thermostats, or with automatic reset low limit thermostats and manual reset circuits as indicated below:

   a. For installations where all low limit thermostats can be mounted on the exterior of the unit, or inside the unit on the same side as the access door, and within 8 feet of the finished floor, manual reset low limit thermostats may be used.
   b. For installations where any low limit thermostat is mounted above 8 feet over the finished floor or on the interior of the unit on the opposite side of the access door, automatic reset low limit thermostats with manual reset circuits must be used.
   c. Low limit thermostat arrangements must meet the installation details indicated in the specifications that follow, and must meet the manufacturer's installation requirements.

2. Low limit thermostats shall be snap-acting contact thermostats with vapor-charged sensing element. Thermostat shall have normally closed SPST main contact and normally open SPST auxiliary contact. Main contact shall be rated 16 A inductive load at 120 VAC. Auxiliary contact shall be rated 16 A inductive load at 120 VAC.

   a. Thermostat shall have setpoint range of 15°F –55°F.
   b. Thermostat shall have a 20-foot long remote bulb strung in free air downstream of the heating coil but upstream of the cooling coil. The control shall respond to the lowest temperature along any one foot section of sensing element.
   c. The coil shall have the manufacturer's recommended coverage, with 20' element per 25 square feet of installed area minimum. Provide multiple thermostats wired in series where the coil area exceeds the maximum coverage.
   d. Temperature sensing elements shall be strung in free air and shall not be supported from the face of the coil to prevent the temperature of the coil media from affecting the element reading. Where element is bent to turn in air stream, provide a manufactured insulated capillary mounting clip at each turn point. Capillary mounting clip shall be Klipet CC-1G-K, M-648-K copper clad mounting clip (only if element insulated from metal-to-metal contact with polyethylene tubing around element within capillary clip), or approved equivalent.
   e. The thermostat shall only be installed in the vertical position, with the sensing bellows on the bottom of the thermostat. The thermostat shall be mounted above the capillary sensing tube and the sensing tube shall run horizontally, below the bellows.

3. Manual reset low limit thermostats shall be operate by manual reset (no fixed differential). Thermostat shall be Johnson Controls A70HA-1C, Robertshaw T322, or approved equivalent.

4. Automatic reset low limit thermostats shall operate on a fixed 5°F differential. Thermostat shall be Johnson Controls A70GA-1 or approved equivalent.

a. Application of automatic reset low limit thermostats requires the pairing of a manual reset circuit. That manual reset circuit may be achieved with a latching relay and pushbutton reset, or with a packaged fan safety relay board with manual reset switch, at contractor's option. The reset button may be located at the unit in a remote enclosure, or inside the unit control enclosure, at contractor's option.

F. Room Temperature Sensor:

1. Room temperature sensors listed in this section shall be for auxiliary sensing applications only, as indicated on the Drawings, Sequences of Operation, or Points Lists. Room temperature sensors applied to terminal unit controllers are specified under Room Smart Sensors.
2. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD. Room temperature sensor covers shall all match on the project, with the exception of sensor type S2 listed below.
   a. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, ±1% at 25°C or ±0.36°F accuracy.
   b. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, ±1% at 25°C or ±0.36°F accuracy.
3. Temperature sensors installed in occupied spaces shall have plastic covers that match the Room Smart Sensors on the project.
4. Temperature sensors installed in common areas (corridors) or secure areas shall be box mounted with flush stainless steel wall plate.
5. All temperature sensors installed on exterior walls shall include insulated backing, utilizing 0.25" closed cell foam pads as a minimum.

2.2 HUMIDITY SENSOR

A. General Purpose Duct Relative Humidity Sensor:

1. Sensor shall employ bulk polymer resistance or capacitance technology, 3% RH accuracy, 4-20 mA or 0-5 VDC transmitter factory matched and calibrated and replaceable tip. Sensor may incorporate integral temperature sensor. Sensor shall be ACI A/RH3-D or approved equal.

B. General Purpose Room Relative Humidity Sensor:

1. Sensor shall employ bulk polymer resistance or capacitance technology, 3% RH accuracy, 4-20 mA or 0-5 VDC sensor transmitter factory matched and calibrated and replaceable tip.. Sensor may incorporate internal temperature sensor. Sensor shall be ACI A/RH3-R, JCI HT-6703-0N00W, Mamac HU-225-3 or approved equal.

C. General Purpose Outside Relative Humidity Sensor:

1. Sensor shall employ bulk polymer resistance or capacitance technology, 3% RH accuracy, 4-20 mA or 0-5 VDC transmitter factory matched and calibrated and replaceable tip. Sensor may incorporate integral temperature sensor. If not included in base model, provide sun shield. Sensor shall be ACI A/RH3-O or approved equal.

2.3 PRESSURE SENSOR

A. General Purpose Air Differential Pressure Transmitter:

1. Transmitter range shall be as indicated on the Points List. Transmitter shall be a fixed range device, multi-range devices are not acceptable.
2. Transmitters shall be a two-wire device producing a 4-20 mA output. Accuracy shall be 1% full scale or better, including non-linearity and hysteresis.

3. Transmitters that are panel mounted may be open frame design. Transmitters that are not installed in an auxiliary control panel shall be provided with an enclosure that accommodates a conduit connection.
4. Transmitter shall be Setra model 264, Ashcroft model CXLdp, or Modus model T30.
5. If not designated otherwise on the Points List, sensor ranges shall be as follows:
    a. Fan discharge pressure transmitters shall be unidirectional with the smallest range, which is larger than 1.2 times greater than fan pressure.
    b. AHU downstream (remote from unit) duct static pressure transmitters shall be unidirectional, 0-2.5"w.c. range.
    c. AHU discharge (local to unit) duct static pressure transmitters shall be unidirectional, 0-5.0"w.c. range.
    d. Mixed air and relief air box pressure transmitters shall be bidirectional, ±0.50"w.c. range for air handling units without heat wheels.
    e. Mixed air and relief air box pressure transmitters shall be bidirectional, ±1.00"w.c. range for air handling units with heat wheels.
    f. Building pressure transmitters shall be bidirectional, ±0.10"w.c. range.

2.4 AUTOMATIC CONTROL DAMPERS

A. General:
1. Control dampers shall be provided where indicated on the drawings or as required for proper system operation.
2. Actuators shall be direct coupled.
3. Provide pin extensions.
4. Provide external bearing bracket assembly.

B. Airfoil Dampers: Dampers shall be constructed from minimum 12 gauge extruded aluminum blades and frames. Blades shall be locked to the blade shaft by a positive means other than setscrews. Such means include ribs extruded into the blade that fit slots in the damper shaft and hexagonal shafts that fit tightly in hexagonal holes extruded into the blades.
1. Shafts shall be provided with bearings at all support locations.
2. Dampers shall be equipped with blade and jamb seals and shall have a leakage rate less than 0.1% of maximum flow.
3. Linkage shall be concealed in the jamb out of the air stream where such an arrangement will be accessible for maintenance and lubrication without removal of the unit from the duct system or fan system that it is installed in. In all other cases the linkage shall not be concealed in the frame.
4. Dampers with vertically oriented blades shall be provided with thrust bearings to support the vertical blades.
5. Airfoil dampers shall be provided where fan discharge dampers are required and/or where minimum pressure drop at full flow is necessary.
6. Dampers shall be Ruskin Model CD-40, Greenheck Model VCD-43 or approved equal.

C. Non-Airfoil Blade Dampers shall be constructed from minimum 16-gauge steel or minimum 12 gauge extruded aluminum blades and frames. Blades shall be locked to the blade shaft by a positive means other than setscrews. Such means include ribs extruded into the blade that fit slots in the damper shaft and hexagonal shafts that fit tightly in hexagonal holes extruded into the blades.
1. Shafts shall be provided with bearings at all support locations.

2. Dampers shall be equipped with blade and jamb seals and shall meet the leakage specifications indicated on the damper schedule.
3. Linkage shall be concealed in the jamb out of the air stream where such an arrangement will be accessible for maintenance and lubrication without removal of the unit from the duct system or fan system that it is installed in. In all other cases the linkage shall not be concealed in the frame.
4. Dampers with vertically oriented blades shall be provided with thrust bearings to support the vertical blades.
5. Non-Airfoil dampers shall be provided at locations where Airfoil dampers are not required. Dampers shall be sized to provide adequate pressure drop at full flow to insure adequate control without hunting.
6. Dampers shall be Ruskin CD-36, Greenheck Model VCD-23 or approved equal.

D. Modulating damper sizing shall be based on the following conditions:
1. Minimum velocity - 2000 fpm
2. Maximum velocity - 3000 fpm
3. Minimum pressure drop - 0.2”w.c.
4. Maximum pressure drop - 0.3”w.c.
5. Coordinate with the installing trade contractor any required blank-off plates for dampers that are smaller than duct size.

E. Two position dampers shall be the full size of the duct they are associated with unless otherwise specified.

F. Flow rates for damper sizing shall be based upon the flow rates indicated on the equipment schedules.

2.5 DAMPER ACTUATORS

A. General:
1. Actuators shall be sized with enough torque to close damper against fan shut off pressure. Provide multiple dampers and actuators as required to obtain close off. In all cases torque shall be a minimum 7.5 in-lb/ft2 for opposed blade dampers and 10.5 in-lb/ft2 for parallel blade dampers.

B. Direct Coupled Electric Actuator:
1. Actuators shall have electronic overload or digital rotation sensing circuit to prevent damage to the actuator throughout the full range of movement. End switches to deactivate the actuator at the end of rotation or magnetic clutch are not acceptable.
2. For power-failure/safety applications, a mechanical spring return mechanism shall be used. Non-mechanical forms such as battery back-up and capacitor discharge are not acceptable. The normal position is the position that the actuator must fail to upon loss of control signal or power.
3. Proportional and triac actuators shall have an external gear release. Spring return proportional actuators shall have a manual crank to allow manual positioning when the actuator is not powered.
4. Proportional actuators shall accept a 2 to 10 VDC or 4-20 mA input signal. Actuators shall operate on less than 10 VA.
5. Actuators shall have a direction rotation switch to aid in installation and provide proper control response.
6. Actuators shall be listed under UL873.

7. Actuators shall have a 2-year warranty starting from the date of acceptance.
8. Actuators shall be Belimo, Siemens, or approved equal.

C. In general, unless noted elsewhere, the following shall apply:
1. Air handling unit control dampers shall be 2-10 VDC proportional, spring return actuators. Outdoor air and relief air shall be NC, return air shall be NO.
2. VAV box damper actuators shall be Triac (tri-state).
3. Smoke dampers shall be 2-position, spring return NC.

2.6 AIRFLOW MEASUREMENT

A. General

B. Flow meters shall be as scheduled on the plans and specified here-in.

C. The controls contractor shall provide flow meters and associated installation kits to the mechanical contractor for installation under other sections of the specification

D. Sensing elements shall be adequately supported for the velocities and spans encountered in the duct system.

E. Sensing element probe densities shall be sized according to manufacturer's recommendations according to installed duct size.

F. Enhanced probe densities are required for outside air flowmeters installed upstream of control dampers. Consult manufacturer's recommendations for density required.

G. All necessary power requirements for the transmitter shall be provided under this section of the specification.

H. Air flow measuring stations have been laid out to maximize upstream and downstream straight length. Temperature control contractor shall review locations with the mechanical contractor to maintain requirements for the meter technology. In general unless the meter alters the flow profile as part of its technology then the following minimum general rules shall be followed for installation of sensing probes:

PART 3 - HYDRONIC CONTROL EQUIPMENT

3.1 TEMPERATURE MEASUREMENT

A. The contractor shall provide for installation under other sections of the specification thermometer wells for all temperature transmitters, remote bulb sensors, etc., installed in piping systems and at other locations as indicated on the plans, flow diagrams, details and specifications. When two (2) wells are shown at the same location: One well will be installed for the sensing element. The second well will be installed to allow a separate calibration instrument to be used to calibrate the sensor without removing it from the line; it shall have a cap and chain for protection when not in use.

B. Temperature sensor immersion well and calibration wells (see above) shall be 316 SS ¾" NPT or ½" NPT pipe connection size with ½" NPT female threads. Thermometer wells shall have an overall length of 6". For larger pipe the fluid insertion length shall be 4-1/2". For smaller pipes the insertion length shall be 2- 1/2" with a 2" lag length. For general use, a straight stepped shank may be used, provided it is less than 70% of the manufactures critical velocity rating, otherwise use a heavy duty

tapered shank to meet the required stiffness. Sensor wells internal bore shall match sensor provided; calibration wells shall have 3/8" internal diameter.

C. The contractor shall be responsible for coordination, with the installing trade contractor of the other sections of the specification, the location of all thermometer wells and insertion depths required by this section. The tip of the sensor shall be completely in the process fluid. Thread-o-lets and any required bushings shall be coordinated the installing trade contractor. Sensor shall be installed with thermally conductive paste equal to Omegatherm -201 manufactured by Omega Engineering.

D. Insertion Element Fluid Temperature Sensor

E. Sensor shall be tip sensitive 10,000 ohm Thermistor or 1,000 ohm RTD. Sensors shall be 6" long, with either 3/8" or ¼" diameter screwed or smooth shanks.

F. Thermistor element shall be 10,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, ±1% at 25°C or ±0.36°F accuracy.

G. RTD element shall be 1,000 ohm, with a temperature coefficient of resistance (TCR) compatible with the system installed, ±1% at 25°C or ±0.36°F accuracy.

H. The housing shall be a weather tight cast aluminum utility box and stamped aluminum cover with a full gasket, or UV-resistant polycarbonate box with hinged cover and thumb latch.

I. Acceptable sensors are Precon KTW Series, BAPI BA/10K(1K) or approved equivalent.

3.2 PRESSURE MEASUREMENT

A. The contractor shall provide for installation by others, isolation valves, snubbers, and access fittings to be used at all pressure transmitter and pressure sensor locations. The connections shall be configured by the installer so that the isolation valve isolates the sensor and calibration port (Pete's plug, Schraeder valve, or access fitting) from the process monitored.

1. Provide an engraved 4" x 3" nameplate, white letters on a red background:

WARNING: OPEN EQUALIZING VALVES PRIOR TO OPENING OR CLOSING THE SERVICE VALVES THAT CONNECT THIS TRANSMITTER TO THE PROCESS LINE.

B. This section shall be responsible for coordination of the installation of all pressure sensor taps required under this section of the specification with other sections of the specification.

C. Hydronic Differential Pressure Transmitter

1. The transmitters shall be a high quality HVAC grade with an accuracy of +/- 0.25% of full scale or better (including linearity, hysteresis, and repeatability) with a drift of 0.5% of span per year or less. All wetted parts shall be 316 stainless steel for long life. Units shall be rated for an operating static pressure of 100 psig.
2. Enclosure shall be NEMA 4 weather tight construction with ½" conduit connection and 1/8" NPT process connections.
3. If not designated otherwise on the Points List, sensor ranges shall be as follows:
   a. Pressure transmitters at pumps or in central plant mechanical rooms shall be 0-25 psid.
   b. Pressure transmitters located at end-of run equipment for pump control shall be 0-10 psid.
4. Acceptable manufacturers are Setra model 230 with 3-valve manifold, Graystone model WP-D, or approved equivalent.
5. Transmitters that utilize independent pressure transcuders on the high and low pressure lines are not allowed.

3.3 CONTROL VALVES

A. Valve actuator requirements shall be as follows.
   1. Torque rating shall be based on the valve manufacturers operating torque requirements at the design flows and pressure drops or shall be based on the manufacturers required shut-off torque to achieve 100% flow shut off at pump shut off head on the system in which they are installed, whichever is greater.
      a. For exterior located valves, torque ratings shall be based on 0°F outside ambient temperature.
   2. For power-failure/safety applications, a mechanical, spring return mechanism shall be used. Non-mechanical forms such as battery back-up and capacitor discharge, are not acceptable. The normal position is the position that the actuator must fail to upon loss of control signal or power.
   3. In general the following types of actuators shall be used unless otherwise indicated: Proportional spring return valves (4-20 mA, 0-10 VDC, 3-15 psi) will be used for heating coils on units with outdoor air connections and heat exchangers, refer to sequences or points list for fail-safe position. Proportional non-spring return valves (4-20 mA, 0-10 VDC, 3-15 psi) will be used for cooling coils and reheat coils. Triac or floating valves will only be allowed on VAV box reheat coils, fan coil units, terminal heating equipment, etc.
   4. In general the following types of valves shall be used unless otherwise indicated: Cooling valves shall be ball valves for 3" and smaller, and butterfly valves for 4" and larger. Hydronic heating valves shall be ball valves for 3" and smaller, and butterfly valves for 4" and larger. Steam heating valves shall be globe valves for all applications. Heating and cooling valves on unitary terminal equipment shall be ball-type zone valves.
   5. Ball valves shall be Belimo, Siemens, or Bray. Ball valves shall be threaded bronze body, chrome plated ball, blowout proof stem, Teflon seat, rated at 600 psi W-O-G working pressure, and 35 psi differential pressure.
   6. Ball-type zone valves shall be Belimo. Ball-type zone valves shall be threaded forged brass body, chrome plated brass ball, brass stem, Teflon seat, rated at 360 psi, and 75 psi differential pressure.
   7. Butterfly valves shall be Belimo or Bray. Butterfly valves shall be lug body style, cast iron body, aluminum bronze disk, EPDM seats, and stainless steel shaft. Valves to be selected for maximum open position of 60°.
   8. Electrical actuated valves shall be provided with Belimo, Bray or Siemens actuators. Actuators shall have current limiting circuitry incorporated in its design to prevent damage to the actuator. A gear release shall be provided on the motor to allow for manual override. Modulating actuators shall be rated for a 4-20 mA input signal. Actuators shall be rated for 24 VAC power. The units shall have visual mechanical position indication showing output shaft and vale position.

B. Modulating valve sizing shall be based on the following conditions.
   1. Water Valves:
      a. Minimum pressure drop - 3 psi or equivalent to the waterside pressure drop of the coil it is associated with, whichever is greater.
      b. Maximum pressure drop - 5 psi.
   2. Steam Valves:
      a. For valves in service on lines at or under 35 psig, target pressure drop is 42% inlet absolute pressure.
      b. For valves in service on lines above 35 psig, target pressure drop is 80% inlet gauge pressure.
      c. Valves shall be sized below critical Cv to prevent choked flow.

C. Two position valves shall be the full size of the pipe they are associated with unless otherwise specified.

D. Two-way valve actuators shall be sized to close off tight against the full pump shut off head on the system in which they are installed.

E. Three-way valve actuators shall be sized to close off tight in both directions against 2.5 times the valve pressure drop at full flow.

F. Flow rates for valve sizing shall be based upon the flow rates indicated on the equipment schedules on the drawings.

G. Valve sizing shall consider the valve cavitation coefficient. In no case shall a valve be sized so that the pressure drop through the valve causes cavitation with fluid temperatures and pressures encountered in the system during start up or normal operation. If cavitation is possible in a single valve, select two control valves to be piped in series to avoid cavitation.

3.4 FLOW MEASUREMENT

A. General

1. Flow meters shall be as scheduled on the plans and specified here-in.

2. The controls contractor shall provide flow meters and associated installation kits to the mechanical contractor for installation under other sections of the specification.

3. All necessary power requirements for the transmitter shall be provided under this section of the specification.

4. Temperature control contractor shall review with the mechanical contractor the required upstream and down steam requirements for the meter technology. In general unless the meter alters the flow profile as part of its technology then the following general rules shall be followed:

   a. Single elbow proceeded by greater than 9 diameters – 10 diameters upstream, 5 diameters downstream
   b. Single elbow proceeded by less than 9 diameters – 15 diameters upstream, 5 diameters downstream
   c. Out flowing tee, or pump discharge – 20 diameters upstream, 5 diameters downstream
   d. In flowing tee – 30 diameters upstream, 5 diameters downstream
   e. Multiple bends out of plane – 30 diameters upstream, 5 diameters downstream
   f. Tee – 30 diameters upstream, 5 diameters downstream
   g. Control valve – 30 diameters upstream, 5 diameters downstream
   h. Include with the bid one each of any necessary configuration tools required to set up the meter if the setup cannot be accomplished from the meter electronics package itself to be turned over to the Owner upon project completion.

B. Strap-on Ultrasonic Fluid Flow Measurement – <Liquid>

1. Technology: Strap-on Ultrasonic transit time

2. Range: 0.1 ft/sec to 40 ft/sec

3. Accuracy: +/-1% of reading between 1-40 ft/sec; +/-0.01 ft/sec below 1 ft/s

4. Pipe sizes: 1/2” and Larger

5. Output: 4-20 mA signal proportional to flow rate

6. Installation: Locate sensor heads in the orientation and distance for the pipe size. Couple using provided gel. Only use factory cables between sensor heads and meter.
7. Flow meter shall be Onicon F-4300, Dynasonics TFX Ultra, or Flexim Fluxus F721.

PART 4 - AUXILLARY EQUIPMENT

4.1 CURRENT OPERATED SWITCHES

A. Adjustable Trip Current Switch

1. General: Adjustable trip current switches shall be used on belt driven or coupled equipment. Switches shall be provided with mounting hardware, and securely mounted and located such that they are easily adjustable without the possibility of shock from the starter components.
2. Current operated switch shall be capable of changing the state of an isolated dry contact or switch when a flow of current is sensed in the wire they are monitoring. The isolated output must be rated at 1 A at 30 VAC or VDC, they shall incorporate a status LED, and shall be UL listed. Trip points shall be between 0.5 A to 135 A, depending on motor size and application. Acceptable manufacturers and models are Veris H308, Veris H908, Functional Devices RIBXGH Series.
3. General: Fixed trip current switches shall be used on direct drive equipment. Switches shall be securely mounted and located such that they are easily adjustable without the possibility of shock from the starter components.
4. Current operated switch shall be capable of changing the state of an isolated dry contact or switch when a flow of current is sensed in the wire they are monitoring. The isolated output must be rated at 1 A at 30 VAC or VDC, they shall incorporate a status LED, and shall be UL listed. Trip points shall be between 0.5 A to 135 A, depending on motor size and application. Acceptable manufacturers and models are Veris H300, Veris H900, Functional Devices RIBXGH Series.

B. Current Switch Integral Command Relay: Current operated switches may be provided with integral command relays as required to perform the indicated functions in the sequences of operation at the contractor's option. In addition to the requirements set forth above for the current switch, relay contacts shall be SPST, rated for 5 A at 250 VAC minimum, sized for the application.

C. Current Switch Installation and Configuration

1. For variable speed applications, trip point shall be set with motor at full speed under normal loading conditions (connected to system of service).
2. For variable speed applications, following trip point set at motor full speed, verify proof of operation at motor minimum speed. If current range between minimum and maximum speed prevents reliable proof indication in a single current switch, provide two switches (one for minimum speed and one for maximum speed) and program logic to accommodate proper status indication.
3. Split core current switches are preferred due to their ability to be changed without removal of phase conductors when the equipment has been placed into service. Solid core current transformers will be considered if there are space constraint considerations. If motor current draw is less than listed minimum trip point for the current switch, wrap phase conductor around current switch the minimum number of passes to reach

4.2 CURRENT POWER TRANSFORMERS

A. 24 VAC Control Power Transformers

1. Transformers shall be NEC Class 2 general purpose transformers with primary windings as required by the application and 24 VAC secondary windings rated for 40 VA at 100% power factor. Transformers shall be installed in a suitable enclosure to prevent contact with the primary and/or

secondary terminals when the cover is on the enclosure. Where transformers are provided for installation by others, the transformers shall be provided mounted in the enclosure. The mounting arrangement shall be such that the terminals are accessible for connection without removing the transformer from the enclosure.

2. Transformers with higher VA ratings may be supplied but must be designed and installed to meet all requirements of NEC article 725 when used to serve Class 1, Class 2, or Class 3 low voltage circuits.
3. Where fuses are provided, a minimum of two (2) spare fuses of the same type and rating at each location.

B. 24 VAC Control Power Load Centers

1. Control Power Load Centers are used for distributed 24 VAC power supply of terminal control devices.
2. Load Centers shall have NEC Class 2 rated secondary winding circuit distribution. General purpose transformers up to 500 VA shall have 480/277/240/120 VAC primary windings and 24 VAC secondary windings. Primary input terminals shall be finger-safe. Secondary winding distribution shall have circuit breakers to provide 4 Amp overcurrent protection on isolated circuits. Each secondary winding distribution circuit shall have an isolation switch, status indicator light, and screw terminals for termination. Load Center shall be provided with NEMA 1 metal enclosure.
3. Load Center shall be Function Devices model PSH500A or approved equivalent.
4. Load Centers are provided by the temperature controls Contractor, secondary wiring is provided and performed by the temperature controls Contractor, primary wiring and conduit is provided and performed by the Division 26 Contractor.

PART 5 - WIRING MATERIALS AND METHODS

5.1 WIRING

A. All wiring required for work under this section of the specification shall be provided under this section of the specification unless otherwise specified.

B. Interlock wiring as shown on the electrical drawings is the responsibility of Division 26 utilizing equipment provided under this section of the specification. Generally this will mean that Division 26 wires the series safety circuit in the starter as shown on the drawings using switches and devices furnished by this section. Equipment not normally mounted by Division 26 shall be mounted as well as furnished by this section. Starter automation as required by the sequences of operation shall be provided and wired by this section with connections made to terminals on the automatic side of the selector switch and on starter coil auxiliary contacts. It is the intention that Division 26 provide all wiring necessary to make the starter run with the selector switch in the hand position and this section provide all additional automation required. Relays, electro-pneumatic switches, etc., required by this section to operate in parallel with the starter coil shall be piloted by auxiliary contacts on the starter furnished under Division 26 and shall not be directly paralleled with the starter coil.

5.2 CONDUIT AND WIRE

A. All wiring will comply with applicable codes and regulations and will be as specified in the applicable portions of this section of the specification, the electrical section of the specification, and as indicated on the drawings

B. Open wiring will be permitted: above lay-in ceilings, and unfinished spaces above 8’ AFF.] Cables shall be supported with "J-Hooks" a minimum of every six feet. Bridal rings can be used when supporting a maximum of 6 wires. Support devices are to be attached to permanent structure.

5.3 CONDUIT MATERIAL

A. Electrometallic tubing shall be installed for all exposed work and for all concealed work in applications where conduit is required.

B. PVC conduit shall be used for all conduit installed below ground or under concrete. Where installed under concrete, provisions shall be made to assure a minimum cover of 2 inches of concrete during and after the pour. Where installed underground, a minimum of 18 inches of cover shall be provided. PVC conduit shall transition to heavy wall conduit or electrometallic tubing (as required by the application and defined in the specification) within 2 inches of the point where it emerges from the ground or concrete in which it is installed.

C. Jacketed flexible steel conduit (Sealtite) shall be used in wet areas where flexible conduit connections are required and at connections to all motorized equipment and motors. For work under this specification, all equipment rooms are considered to be wet areas. Heavy wall conduit shall be used for exterior locations unless specified otherwise. Aluminum conduit shall be used at the following locations.

D. Conduit shall be by Allied, Triangle, Republic, Youngstown, Carlon, Rob Roy, or approved equal.

5.4 CONDUIT INSTALLATION

A. Conduit bends shall be made with standard hickeys of proper size; radius of bends to be at least 6 times the diameter of the conduit. Runs between outlets shall not contain more than the equivalent of three-quarter bends. Conduit runs shall be continuous from outlet to outlet, outlet to cabinet, etc.

B. Conduits shall be installed with pitch toward outlet box wherever possible. All heavy wall conduits shall have two locknuts and a bushing at each termination outlet box, junction box, etc., except where terminated in a threaded hub. Fittings on electrometallic tubing shall be compression type.

C. A bushing shall be used where conduit enters a panel box. Bushing for No. 4 AWG or larger shall be insulated type with provisions for grounding as type “BL” made by O-Z Electric Company, or approved equal.

D. All exposed conduits shall be installed parallel or at right angles to the building walls or floors

E. Expansion fittings shall be provided at all conduits across the building expansion joints. Fittings shall be Type “AX” or “TX” as made by O-Z Electric Company, or approved equal. Provide copper bonding jumper at each expansion fitting.

F. Exposed conduit shall be securely fastened in place on maximum 5 ft. intervals for ¾” through 2-1/2” nominal sizes. Supports may be one hole malleable straps or other approved devices. No perforated metal straps will be permitted.

G. Pull boxes and junction boxes shall be installed where indicated on the drawings or where required to facilitate wire installation. Locate in conjunction with other trades so as to install without conflict with other materials or equipment.

H. Care shall be used to avoid proximity to heat ducts and/or steam lines. Where crossings are unavoidable, conduit shall clear covering of line by at least six inches.

I. All conduit for automation wiring shall be identified by painting junction box covers as follows: Voltages above 24 shall be blue and red, voltages at 24 or below shall be blue.

J. Provisions for Wiring: Wire and cable of the sizes and types shown on the plans and/or hereinafter specified shall be furnished and installed by the Contractor. All wire and cable shall be new soft drawn copper and shall conform to all the latest requirements of the National Electrical Code, IPCEA, and shall meet the specifications of the ASTM.

K. Power Conductors: All feeder and branch circuit wire shall be 600 V insulated of THHN type unless shown or specified to be otherwise. No wires less than No. 12 gauge shall be used except for control circuits or low voltage wiring. Wire sizes No. 14 to No. 10 shall be solid except where otherwise indicated. Wire sizes No. 8 and larger shall be stranded. All wire sizes shown are American Wire Gauge sizes. Where

power conductors are run in cable tray, furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 318 and/or 725.

L. Acceptable Manufacturers: Cable and wire shall be a standard type as manufactured by General Electric Company, National Electric Company, U. S. Rubber Company, Simplex, General Cable Company, Carol, Anaconda, Rome, Southwire, Belden, Alpha, Houston Wire and Cable, or ITT Royal.

M. Motor Interlock Wiring: Interlock circuit wiring shall be No. 14 solid or stranded wire. Stranded wire only shall be used where wiring is used for flexible wiring harnesses. Stranded control wire shall be provided with crimp type spade terminators. Interlock circuit wiring shall be color-coded or numbered using an identical number on both ends of the conductor. Wire numbers shall be installed before conductors are pulled. Where motor interlock conductors are run in cable tray, furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 318 and/or 725.

N. Automation Input/Output Wiring: Wiring serving inputs and outputs from the automation system shall be cables consisting of single or multiple twisted pairs, an overall aluminum foil type shield with a 22 AWG stranded drain wire. Cables installed without conduit shall be plenum rated and comply with NEC article 725. Multi-conductor cable shall only be used where all the points are at a single location and for the same device (i.e., variable frequency drives, each individual motor starter). Single conductor cables shall be used for all temperature transmitters, pressure transmitters, flow meters, differential pressure switches, control valves and any other locations where the points are not grouped together at the same device. Where automation input/output wiring is run in cable tray furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 318 and/or 725. Conductors shall be minimum #18 wire gauge, strained copper. All wires shall be continuous from outlet to outlet and there shall be no unnecessary slack in the conductors.

O. Floor level network (FLN): Wiring serving communication trunks from the automation system shall be as required by the network protocol. Cables installed without conduit shall be plenum rated and comply with NEC article 725. Where wiring is run in cable tray furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 318 and/or 725.

P. Splices: All splices, taps, and terminations shall be made at outlet, junction, or pull boxes. Wire to No. 6 gauge shall be spliced using Scotchlok wire nuts. No Bakelite wirenuts shall be used. Wire No. 6 and larger shall be spliced using solderless connectors as manufactured by Penn Union Company. Splices No. 6 and larger shall be insulated by taping with plastic vinyl tape as manufactured by (3M) Minnesota Mining and Manufacturing Company. Splices shall not be permitted in automation input and output wiring without specific written authorization from the Engineer. If such a splice is approved, the location of the splice shall be clearly documented on the “As Built” drawings. Splices in automation wiring, if necessary, shall be made using Thomas & Betts STA-KON connectors installed per the manufacturer’s directions to maintain NEMA specified voltage drops and wire retention forces.

Q. Refer to Division 01, Section 018000 "Commissioning" and Division 23, Section 239500 "Mechanical Systems Commissioning" for detailed requirements for commissioning responsibilities and activities.

5.5 CLOSEOUT PROCEDURES

A. Contractor shall provide complete diagrams of the control system including flow diagrams with each control device labeled, a diagram showing the termination connections, and an explanation of the control sequence. The diagram and sequence shall be framed and protected by glass and mounted next to controller.

PART 6 – SEQUENCE

GENERAL

These sequences are intended to be performance based. Implementations that provide the same functional result using different underlying detailed logic will be acceptable.

Unless otherwise indicated, control loops shall be enabled and disabled based on the status of the system being controlled to prevent windup.

When a control loop is enabled or reenabled, it and all its constituents (such as the proportional and integral terms) shall be set initially to a neutral value.

A control loop in neutral shall correspond to a condition that applies the minimum control effect, i.e., valves/dampers closed, VFDs at minimum speed, etc.

When there are multiple outdoor air temperature sensors, the system shall use the valid sensor that most accurately represents the outdoor air conditions at the equipment being controlled.
Outdoor air temperature sensors at air-handler outdoor air intakes shall be considered valid only when the supply fan is proven ON and the unit is in occupied mode or in any other mode with the economizer enabled. The outdoor air temperature used for optimum start, plant lockout, and other global sequences shall be the average of all valid sensor readings. If there are four or more valid outdoor air temperature sensors, discard the highest and lowest temperature readings.

The term “proven” (i.e., “proven ON”/“proven OFF”) shall mean that the equipment’s DI status point (where pro-vided, e.g., current switch, DP switch, or VFD status) matches the state set by the equipment’s DO command point.

The term “software point” shall mean an analog variable, and “software switch” shall mean a digital (binary) variable, that are not associated with real I/O points. They shall be read/write capable (e.g., BACnet analog variable and binary variable).

The term “control loop” or “loop” is used generically for all control loops. These will typically be PID loops, but proportional plus integral plus derivative gains are not required on all loops. Unless specifically indicated otherwise, the guidelines in the following subsections shall be followed.

Use proportional only (P-only) loops for limiting loops.

Do not use the derivative term on any loops unless field tuning is not possible without it.

To avoid abrupt changes in equipment operation, the output of every control loop shall be capable of being limited by a user adjustable maximum rate of change, with a default of 25% per minute.

All set points, timers, deadbands, PID gains, etc. listed in sequences shall be adjustable by the user with appropriate access level whether indicated as adjustable in sequences or not. Software points shall be used for these variables. Fixed scalar numbers shall not be embedded in programs except for physical constants and conversion factors.

Values for all points, including real (hardware) points used in control sequences shall be capable of being overridden by the user with appropriate access level (e.g., for testing and commissioning). If hardware design prevents this for hardware points, they shall be equated to a software point,
and the software point shall be used in all sequences. Exceptions shall be made for machine or life safety.

Every sensor input data point shall incorporate input value filtering, a time averaged value is preferable to change of value (COV) techniques. Due to the great variety in filtering requirements based on sensed

value stability and process variable use, a prescriptive specification will not be provided in this guideline requirement. Rather, this requirement is to ensure that filtering is present in some form so that it may be adjusted during system tuning and acceptance, if so required, at no additional programming or cost.

Network dependent processes should be avoided. For control processes, particularly control loops, all input sensor readings, output device operations, and logic control algorithms shall reside in a single field controller. For particularly difficult applications, or for less critical applications, network dependent processes should be presented specifically to the Engineer during the Shop Drawing submittal for review and acceptance.

Graphics:

All graphics shall display time of day, date, outdoor air temperature and outdoor air relative humidity.
Cooling Plant Graphics:
Graphics showing plate and frame heat exchangers and pumps shall include outdoor air wet-bulb temperature. When applicable, cooling plant graphics shall show number of pressure reset requests.
Air Handling System Graphics:
When applicable, system graphics shall show number of incoming heating and cooling requests, pressure reset requests, total VAV flow, total VAV flow setpoint, Max VAV damper position, and Min VAV damper position.
VAV Graphics:
All VAV graphics shall include room name and number, and a link to the RTU which serves the VAV.
Air Handling Unit Summary Table:
A summary table shall include a list of all rooftop and/or air handling equipment. Columns shall include fan status, fan speed, static pressures, discharge temperature, valve and damper positions.
VAV Summary Table:
A summary table for each air handling system shall include a list of all VAVs served by the system. Columns shall include air flow, air flow setpoint, damper position, supply temperature, valve position, zone temperature, zone temperature setpoint, user adjustment lockout.

FCU Summary Table:
A summary table for each air handling system shall include a list of all FCU's served by the system. Columns shall include fan speed, fan status, supply temperature, valve position, zone temperature, zone temperature setpoint, user adjustment lockout.

User adjustable temperature dial or slider provided on room temperature sensors. Provide a user adjustment lockout to disable local control.

Variable Air Volume Box with Reheat

Occupied Cooling Mode: Upon proof of fan status for the associated air handler, the VAV damper shall modulate between the minimum and maximum cooling airflow rates to maintain the zone temperature to the zone thermostat cooling set point, 74°F (adj).

Occupied Heating Mode: When the zone temperature drops .5°F (adjustable) below the cooling setpoint and the heating system is on, the VAV shall switch from cooling mode to heating mode and open the VAV damper to the minimum heating airflow rate and modulate the reheat valve to maintain the zone temperature to the zone thermostat cooling set point.

Cooling DAT Request:

Up to 3 cooling requests are sent to the air handler. One for each of the following:

If the zone is 3°F above setpoint for 2 minutes (2°F differential), send 3 requests.
Else if the zone is 1°F above setpoint for 2 minutes (1°F differential), send 2 requests.
Else if the cooling loop is more than 95% (10% differential), send 1 request.
Else if the cooling loop is less than 95%, send 0 requests.

Heating DAT Request:

Up to 3 heating requests are send to the air handler.

If the zone is 3°F below setpoint for 2 minutes (2°F differential), send 3 requests.
Else if the zone is 1°F below setpoint for 2 minutes (1°F differential), send 2 requests
Else if the heating loop is more than 95% (10% differential), send 1 request.
Else if the heating loop is less than 95%, send 0 requests.

When the zone temperature rises to match the zone thermostat cooling setpoint, the VAV shall switch from the heating mode to the cooling mode.

When an air handler is in the un-occupied mode and the status is off, the BAS shall monitor all associated VAV zone temperatures. When a VAV zone temperature drops 10°F (adjustable) below its cooling setpoint or rises 10°F (adjustable) above its cooling setpoint the air handler shall start and operate until all zones are within 5°F (adjustable) of setpoint or the occupied schedule is activated.

If HWS temperature is below 75 deg (adj) – Heat is not available. If heat is not available VAV minimums go zero CFM.

Variable Air Volume Box without Reheat

The VAV damper shall modulate between the minimum and maximum airflow rates to maintain the zone temperature.

Cooling DAT Request:

Up to 3 cooling requests are sent to the air handler. One for each of the following:

If the zone is 3°F above setpoint for 2 minutes (2°F differential), send 3 requests.
Else if the zone is 1°F above setpoint for 2 minutes (1°F differential), send 2 requests.
Else if the cooling loop is more than 95% (10% differential), send 1 request.
Else if the cooling loop is less than 95%, send 0 requests.

Heating DAT Request:

Up to 3 heating requests are sent to the air handler.

If the zone is 3°F below setpoint for 2 minutes (2°F differential), send 3 requests.
Else if the zone is 1°F below setpoint for 2 minutes (1°F differential), send 2 requests
Else if the heating loop is more than 95% (10% differential), send 1 request.
Else if the heating loop is less than 95%, send 0 requests.

If HWS temperature is below 75 deg (adj) – Heat is not available. If heat is not available VAV minimums go zero CFM.

Duct Static Pressure Request:

Up to 2 pressure increase requests are sent to the air handler. One for each of the following:

Damper is 100% open. Cease request when damper is less than 85% open.
Zone is 2°F above setpoint. Cease request when zone is within 1°F of setpoint.
Importance Multiplier for pressure requests shall be limited to 1 or less, if set greater than 1 the air handler will remain at max pressure.

CONSTANT VOLUME FAN COIL UNIT

Overview:

The fan coil unit maintains room setpoint using a deadband, two different setpoint are used for heating and cooling. When a room humidity sensor is available, the unit also maintains zone humidity by opening the cooling valve overriding the temperature sequence.

The unit includes a fan, modulating heating and cooling valves, a discharge temperature sensor a zone temperature sensor, and filters.

Zone Temperature Setpoint:

See “Generic Thermal Zones” for set points.

Zone Temperature Control:

Zone Temperature is controlled by modulating the cooling and heating valves.

Zone Cooling:
When the zone state is cooling, the cooling loop output shall be mapped to control the cooling valve from 0% to 100%.

Heating valve is OFF.

Zone Heating:
When the zone state is heating, the heating loop shall maintain space temperature at the heating set point by modulating the heating valve.

Cooling valve is OFF.

From 0% to 50%, the heating-loop output shall reset the discharge temperature set point from the current

User adjustable temperature dial or slider provided on temperature sensors. Provide a user adjustment lockout to disable local control.

Zone Deadband:
When the zone state is deadband, both valves are closed.

Fan Control:

The fan runs at constant speed when the unit is operating in any mode other than unoccupied. Fan speed to be set by balancing agent.

Heating Hot Water Plant Pressure Request:

If the valve position is greater than 95%, send 1 request until the valve position is less than 85%.

Else if the valve position is less than 95%, send 0 requests.

Importance Multiplier for pressure requests shall be limited to 1 or less, if set greater than 1 the heating loop will remain at max pressure.

Multiple Units Serving One Room:

When multiple fan coil units serve a common room, one unit is setup as the leader and performs the Zone Temperature Control calculations. The rest of the units are setup as followers, using the cooling and heating loop outputs from the leader unit.

When multiple zone temperature sensors are installed, the average of all sensors is used for control.

Alarms:

Fan Alarm:

Indicated by the status being different from the command for a period of 15 seconds.

Commanded ON, status OFF: Level 2
Commanded OFF, status ON: Level 4

Leaking Valve:
If the heating valve position is 0% for 15 minutes, DAT is above room temperature by 10°F, and the fan serving the zone is proven ON, generate a Level 4 alarm.

If the cooling valve position is 0% for 15 minutes, DAT is below room temperature by 10°F. and the fan serving the zone is proven ON, generate a Level 4 alarm.

DEDICATED OUTSIDE AIR SYSTEM (DOAS-1)

Overview:

This variable volume dedicated outside air unit serves variable volume pressure independent terminal units.

The unit is provided with a pumped hot water preheat coil, chilled water cooling, series heat recovery coil, reheat coil, modulating supply fans, and filters.

The supply fan modulates to maintain discharge pressure.

The preheat coil maintains constant discharge temperature when ambient conditions are cold.

The cooling coil maintains constant discharge temperature when ambient conditions are humid.

The series energy recovery coil preconditions outdoor air and provides reheat capability during the cooling season.
The reheat coil maintains discharge temperature based on outdoor air dry bulb reset.

Safeties:

See airflow diagrams for location of safety devices.

Freeze Stat Trip / Preheat Discharge Air Temperature drops below 40° F (TL-PHC): Shut off AHU, close outside air damper, preheat valve & pump remains enabled and modulates to maintain discharge temperature setpoint, and open chilled water valve 100%.

Supply Air pressure High Limit (PHL-SA)

Supply Air Smoke Detector

Alarms

Supply Fan status (AL-SF) doesn't match fan command = Shut off AHU, close Outside air damper, preheat valve & pump remains enabled and modulates to maintain discharge temperature setpoint,

If Preheat pump status does not match the command status after 1 minute (adj) alarm.

Schedule:

See "Zone Groups" for scheduling.

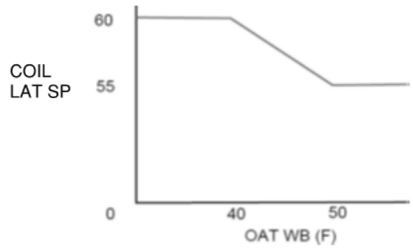
Startup/Shutdown Sequence:

When the unit is commanded on, the AHU outside air damper shall open Once the outside air damper is proven open the supply fan shall start. When the unit is first enabled during ambient temperatures below 40°F, the preheat setpoint is temporarily increased to 85°F and it resets down to 55°F over a period of 20 minutes.

The individual control valves shall be modulated to maintain temperature as outlined below.

Preheat and Cooling Coil Temperature Control:

When O.A. temp is below 45 degrees the preheat coil shall be controlled by the T-PHC sensor, above 45 degrees the coil shall be controlled by the T-CC sensor. In this case the T-CC sensor shall provide an input to a software based PID-type control loop. The output of this control loop shall be between - 100% and 100% and shall be used to modulate the pre-heat heating water valve and cooling coil valve in order to maintain the coil leaving air temperature set- point without simultaneous heating and cooling. The pre-heat valve shall be commanded full open at -100% PID output and shall be full closed at 0% PID output. The cooling coil control valve shall be full closed at 0% PID output and shall be full open at 100% PID output. The coils shall control to a supply air set-point as shown below:



When the unit is first enabled during ambient temperatures below 40°F, the preheat setpoint is temporarily increased to 85°F and it resets down to 55°F over a period of 20 minutes.

Series Energy Recovery Coil Control:

When O.A. temperature is above 60 degrees Command valve ER1 open and ER2 Closed. When O.A. temperature falls below 55 deg (adj) command ER1 closed and ER2 open.

Reheat Valve Control:

The valve modulates to maintain discharge temperature when the supply fan is proved ON. The reheat setpoint shall adjust based on outdoor air dry bulb temperature reset as noted below.

Outside Air Temperature	Reheat Discharge Air Temperature Setpoint
53°F (adjustable)	55°F (adjustable)
30°F (adjustable)	60°F (adjustable)

Preheat Coil Pump Control:

The pump is enabled when the preheat valve is more than 5% open or when the outside air temperature is below 40°F or when ER1 is open. The pump is disabled when the preheat valve is closed and the outside air temperature is above 42°F, or when ER1 is closed.

In the event of a Freezestat, the pump is commanded to start.

MULTIPLE-ZONE VAV AIR HANDLING UNIT (AHU B-1)

Overview:

This variable volume air handler serves terminal units with reheat.

The unit is provided with (4) modulating supply fans, a modulating return fan, hot water preheat and chilled water coils, a ventilation air VAV, modulating economizer, return air, and relief air dampers, and filters.

Discharge pressure and temperature are reset based on zone demand. The temperature reset is disabled when ambient conditions are humid to prevent high space humidity.

Ventilation is supplied by VAV from DOAS unit:

The economizer damper modulates to maintain discharge air temperature at setpoint when enabled.
The relief air damper modulates to maintain building pressure setpoint.
The supply fans modulate to maintain discharge pressure.
The return fan modulates to maintain return air pressure setpoint.
The unit sends plant enable and pressure reset requests to the cooling and heating plants based on discharge temperature and valve position.

Safeties:

Freeze Stat Trip / Preheat Discharge Air Temperature drops below 40° F (TL-PHC): Shut off AHU, close outside air damper, preheat valve & pump remains enabled and modulates to maintain discharge temperature setpoint, and open chilled water valve 100%.

Supply Air pressure High Limit (PHL-SA).

Alarms

Supply Fan status (AL-SF) doesn't match fan command = Shut off AHU, close Outside air damper, preheat valve & pump remains enabled and modulates to maintain discharge temperature setpoint.

Return fan status (AL-RF) doesn't match fan command = Shut off AHU, close Outside air damper, preheat valve & pump remains enabled and modulates to maintain preheat coil leaving air temperature setpoint.

If Preheat pump status does not match the command status after 1 minute (adj) alarm.

Schedule:

See "Zone Groups" for scheduling.

Set-point Reset Logic

Set-point reset logic and zone/system reset requests, where referenced in sequences, shall be implemented as described below.

Requests:
A "request" is a call to reset a static pressure or temperature set point generated by downstream zones or air-handling systems. These requests are sent upstream to the plant or system that serves the zone or air handler that generated the request.

For each downstream zone or system, and for each type of set-point reset request listed for the zone/system, provide the following software points:

Importance-Multiplier (default = 1), for pressure requests the multiplier must be equal or less than Request-Hours Accumulator. Every X minutes (default X=5 minutes), add X divided by 60 times the current number of requests to this request-hours accumulator point.

System Run-Hours Total. This is the number of hours the zone/system has been operating in any mode other than unoccupied mode.

Cumulative%-Request-Hours. This is the zone/system Request-Hours divided by the zone/system run-hours (the hours in any mode other than unoccupied mode) since the last reset, expressed as a percentage.

The Request-Hours Accumulator and System Run-Hours Total are reset to zero either automatically for an individual zone/system when the System Run-Hours Total exceeds 400 hours, or manually by a global operator command. This command will simultaneously reset the Request-Hours point for all zones served by the system.

Number of Requests:
See zone and air-handling system control sequences for logic to generate requests.

Multiply the number of requests determined from zone/system logic times the Importance-Multiplier and send to the system/plant that serves the zone/system. See system/plant logic to see how requests are used in the reset logic.

Alarms:

A Level 4 alarm is generated if the zone Importance-Multiplier is greater than zero, the zone/system Cumulative%-Request-Hours exceeds 70%, and the total number of zone/system run hours exceeds 40.

Discharge Air Static Pressure Control:

Discharge Air Static Pressure Setpoint:

The set point shall be reset using control loop logic. Each terminal unit sends up to 2 pressure requests to the air handler, the unit sums all the requests and uses the sum as an input to a control loop, the loop output is used to reset the set point from SPmin to SPmax.

Use 0.3" w.c. and 1.2" w.c as initial values.

Discharge Air Static Pressure PID:
When the fan is proven ON, the loop is enabled.

A differential pressure sensor is located downstream in the duct such that the maximum pressure reading is 1.2" w.c. when all the zones are satisfied. The sensor references zone pressure.

The static pressure sensor provides an input to the loop, the loop set point is as calculated above, and the loop output is used to modulate fan speed.

Supply Fan Staging:

On unit start-up enable 3 fans (adj). The supply fan speed shall be controlled by a PID loop control with an input from a duct static pressure sensor. The supply fan shall maintain 1.25" W.C. (adjustable) static pressure. When current operating supply fans exceeds 50% (adj)speed for 60 seconds (adj), to maintain static pressure an additional supply fan shall be enabled – when current operating fans drop below 30% (adj)speed for 60 seconds (adj), speed one fan shall be disabled as required to maintain duct static pressure. Rotate lead fan every 30 days (adj) Rotation to occur 7 AM (adj)

Discharge Air Temperature Control:

Discharge Air Temperature Setpoint:
Occupied mode:
The setpoint is allowed to reset based on the zone cooling and heating requests using a control loop.

The controller subtracts the sum of all heating requests from the sum of all cooling requests and uses the result as an input to a reverse acting control loop with a setpoint of zero. The loop output is mapped to reset the discharge air setpoint from 55°F (adj) when the loop is at 0%, to 70°F (adj) when the loop is at 100%

Discharge Air Temperature PID:
Discharge air temperature shall be controlled to set point using a control loop whose output is mapped to sequence the economizer, heating coil and cooling coil without simultaneous heating and cooling.

The loop shall be biased such that it starts calculating with both valves closed.
Separate gains shall be provided for each section of the control map to provide stable control.

Chilled Water Valve Control:

As the discharge temperature control loop output goes from 51% to 100%, the valve is commanded from 0% to 100%.

If the fan status is OFF or the outside air temperature is below 54°F the valve is locked out.

Pre-heat Coil Water Valve Control:

The valve modulates together with the cooling valve to maintain discharge air temperature when the fan is proved ON and the economizer is inactive.

As the discharge temperature control loop output goes from 0% to 50%, the valve is commanded from 100% to 0%. If the unit is economizing, the valve is locked out.

Chilled Water Pressure Reset Request:

If the supply air temperature exceeds the supply air temperature set point by 5°F for 2 minutes, send 3 requests.

Else if the supply air temperature exceeds the supply air temperature set point by 3°F for 2 minutes, send 2 requests.

Else if the CHW valve position is greater than 95%, send 1 request until the CHW valve position is less than 85%.

Else if the CHW valve position is less than 95%, send 0 requests.

Call for Cooling:

Send the chiller plant that serves the system a chiller plant request as follows:

If the CHW valve position is greater than 95%, send 1 request until the CHW valve position is less than 10%.

Else if the CHW valve position is less than 95%, send 0 requests.

The chiller plant will start when there is at least one request for 5 minutes, and stop when there are no requests for 5 minutes, after a minimum run-time has elapsed.

Actuation of the chilled water valve resulting from a low limit / freeze stat safety shall not produce a call for cooling request. However, this condition shall result in the enabling of a chilled water system pump to circulate water. See the chilled water plant pump control sequence.

Hot Water Pressure Reset Request:

If the supply air temperature is 30°F less than set point for 5 minutes, send 3 requests.

Else if the supply air temperature is 15°F less than set point for 5 minutes, send 2 requests.

Else if HW valve position is greater than 95%, send 1 request until the HW valve position is less than 85%.

Else if the HW valve position is less than 95%, send 0 requests.

Call for Heating:

Send the heating hot-water plant that serves the AHU a heating hot-water plant request as follows:

If the HW valve position is greater than 95%, send 1 request until the HW valve position is less than 10%.

Else if the HW valve position is less than 95%, send 0 requests.

The hot water plant will start when there is at least one request for 5 minutes, and stop when there are no requests for 5 minutes, after a minimum run-time has elapsed

Return fan speed:

Upon proof the of supply fan status, the return fan shall enable and modulate between minimum speed initially set at 0% and maximum speed initially set at 100% to maintain the return air pressure set point to a positive pressure initially set at .15" W.C. (adj)

Economizer Damper Control:

Economizer shall be disabled whenever the outside air dry bulb temperature is above 62°F (adj) or the outside air dewpoint temperature is above 55°F.The damper is commanded closed when the schedule is unoccupied, or when the unit is off, or when economizer is disabled, or when the heating valve is open, or when any safety is tripped. When enabled the damper modulates from 0% to 100% as commanded by the output of the discharge air temperature PID.

Return Air Damper Control:

When the unit is enabled and economizer disabled the return damper is commanded to 100% (adj) open.

When the economizer is enabled the return damper shall track opposite of economizer damper.

Relief Air Damper Control:

When the unit is enabled the relief air damper modulates to maintain building pressure setpoint (.008" W.C. adj).

Preheat Coil Pump Control:

The pump is enabled when the preheat valve is more than 5% open or when the outside air temperature is below 40°F and disabled when the valve is closed and the outside air temperature is above 42°F.

In the event of a Freezestat, the pump is commanded to start.

Gaphics:

All graphics shall display time of day, date, outdoor air temperature and outdoor air relative humidity.

Air Handling System Graphics:

System graphics shall show number of incoming heating and cooling requests, pressure reset requests, total VAV flow, total VAV flow setpoint, Max VAV damper position, and Min VAV damper position,

VAV Graphics:

All VAV graphics shall include room name and number, and a link to the AHU which serves the VAV.

Air Handling Unit Summary Table:
A summary table shall include a list of all rooftop and/or air handling equipment. Columns shall include fan status, fan speed, static pressures, discharge temperature, valve and damper positions.

VAV Summary Table:
A summary table for each air handling system shall include a list of all VAVs served by the system. Columns shall include air flow, air flow setpoint, damper position, supply temperature, valve position, zone temperature, and zone temperature setpoint.

MULTIPLE-ZONE VAV AIR HANDLING UNIT (STACK AHU'S)

Overview:

This variable volume air handler serves terminal units with reheat.

The unit is provided with (1) modulating supply fan, (2) modulating relief fans with (2) relief isolation dampers, chilled water coils, a ventilation air VAV, modulating economizer, (2) return air dampers, and filters.

There are (4) primary zones supplied by VAV with reheat. Downstream of primary zone VAV's are secondary zone VAV boxes without reheat.

Discharge pressure and temperature are reset based on primary zone demand. Secondary zone boxes act as a means to limit over cooling in interior spaces.

Thermostats in secondary zones include an occupancy override button. Override adjust the upstream primary zone to 100% (adj) CFM.

Ventilation is supplied by a VAV from DOAS unit.

The economizer damper modulates to maintain discharge air temperature at setpoint when enabled.

The relief air fans modulate to maintain floor pressure setpoint.

The supply fans modulate to maintain discharge pressure.

Safeties:

Freeze Stat Trip (TL-CC): Shut off AHU, close outside air damper, open return air dampers, and open chilled water valve 100%.

Supply Air pressure High Limit (PHL-SA), Return air Low Limit (RA-LL)

Supply and Return Smoke Dampers

Alarms

Supply Fan status (AL-SF) doesn't match fan command = Shut off AHU, close Outside air damper, open return air dampers.
Relief fan status (AL-RF) doesn't match fan command = Alarm

Schedule:

See "Zone Groups" for scheduling.

Set-point Reset Logic

Set-point reset logic and zone/system reset requests, where referenced in sequences, shall be implemented as described below.

Requests:
A "request" is a call to reset a static pressure or temperature set point generated by Primary Zones.
For each primary zone and for each type of set-point reset request listed for the zone/system, provide the following software points:

Importance-Multiplier (default = 1), for pressure requests the multiplier must be equal or less than

Request-Hours Accumulator. Every X minutes (default X=5 minutes), add X divided by 60 times the current number of requests to this request-hours accumulator point.

System Run-Hours Total. This is the number of hours the zone/system has been operating in any mode other than unoccupied mode.

Cumulative%-Request-Hours. This is the zone/system Request-Hours divided by the zone/system run-hours (the hours in any mode other than unoccupied mode) since the last reset, expressed as a percentage.

The Request-Hours Accumulator and System Run-Hours Total are reset to zero either automatically for an individual zone/system when the System Run-Hours Total exceeds 400 hours, or manually by a global operator command. This command will simultaneously reset the Request-Hours point for all zones served by the system.

Number of Requests:
See zone and air-handling system control sequences for logic to generate requests.

Multiply the number of requests determined from zone/system logic times the Importance-Multiplier and send to the system/plant that serves the zone/system. See system/plant logic to see how requests are used in the reset logic.

Alarms:
A Level 4 alarm is generated if the zone Importance-Multiplier is greater than zero, the zone/system Cumulative%-Request-Hours exceeds 70%, and the total number of zone/system run hours exceeds 40.
Discharge Air Static Pressure Control:

Discharge Air Static Pressure Setpoint:
The set point shall be reset using control loop logic. Each Primary zone sends up to 2 pressure requests to the air handler, the unit sums all the requests and uses the sum as an input to a control loop, the loop output is used to reset the set point from SPmin to SPmax.

Use 0.3” w.c. and 1.2” w.c as initial values.

Discharge Air Static Pressure PID:
When the fan is proven ON, the loop is enabled.

A differential pressure sensor is located downstream in the duct such that the maximum pressure reading is 1.2” w.c. when all the zones are satisfied. The sensor references zone pressure.

The static pressure sensor provides an input to the loop, the loop set point is as calculated above, and the loop output is used to modulate fan speed.

Discharge Air Temperature Control:

Discharge Air Temperature Setpoint:
Occupied mode:

The setpoint is allowed to reset based on the zone cooling and heating requests using a control loop.

The controller subtracts the sum of all heating requests from the sum of all cooling requests and uses

the result as an input to a reverse acting control loop with a setpoint of zero. The loop output is mapped to reset the discharge air setpoint from 55°F (adj) when the loop is at 0%, to 70°F (adj) when the loop is at 100%

Discharge Air Temperature PID:
Discharge air temperature shall be controlled to supply air temperature set point using a control loop whose output is mapped to sequence the economizer and cooling coil. The loop shall be biased such that it starts calculating with the cooling coil valve closed.

Chilled Water Valve Control:

As the discharge temperature control loop controls the chilled water valve.

Relief fan control:

Upon proof the of supply fan status and if floor pressure is above 01" w.c. (adj) for thirty seconds the relief fan isolation damper shall open. Upon a proof open of the relief isolation damper the fan shall enable and modulate to maintain floor pressure .008" w.c. (adj). Disable fan if pressure falls below 0.0" w.c. for 2 minutes.

Economizer Damper Control:

Economizer shall be disabled whenever the outside air dry bulb temperature is above 62°F (adj) or the outside air dewpoint temperature is above 55°F, or below 40 degrees (adj). The damper is commanded closed when the schedule is unoccupied, or when the unit is off, or when economizer is disabled, or when any safety is tripped. When enabled the damper modulates from 0% to 100% as commanded by the output of the discharge air temperature PID.

Return Air Damper Control:

When the unit is enabled and economizer disabled the return dampers are commanded to 100% (adj) open.

When the economizer is enabled the return damper shall track opposite of economizer damper.

Secondary VAV Box Control:

VAV shall modulate damper position to maintain zone temperature setpoint when the unit is enabled. Secondary zone temperature sensor shall have an override button to send the associated primary zone to max cooling airflow.

Graphics:

All graphics shall display time of day, date, outdoor air temperature and outdoor air relative humidity.

Air Handling System Graphics:
System graphics shall show number of incoming heating and cooling requests, pressure reset requests, total VAV flow, total VAV flow setpoint, Max VAV damper position, and Min VAV damper position,

VAV Graphics:
All VAV graphics shall include room name and number, and a link to the AHU which serves the VAV.

Air Handling Unit Summary Table:
A summary table shall include a list of all air handling equipment. Columns shall include fan status, fan speed, static pressures, discharge temperature, valve and damper positions.

VAV Summary Table:

A summary table for each air handling system shall include a list of all VAVs served by the system. Columns shall include air flow, air flow setpoint, damper position, supply temperature, valve position, zone temperature, and zone temperature setpoint.

Air Handler (AHU-1) (Serving kitchen and café)

Overview: The system consists of a multiple zone Constant volume AHU system. The air handler includes, cooling coil, reheat coil, Supply fan with VFD and return fan with VFD, and transfer damper. Supply fan has two speeds Low speed 2850 CFM (adj) and high speed 5700 CFM (ADJ)

Safeties: Freezestat and supply fan high pressure limit, and Return Fan High Pressure Limit safeties shall be hardwired to disable the AHU fan. If the safeties described in this paragraph are satisfied then the fan shall run continuously when the DDC system has commanded the fan on.

Supply Fan Speed: The supply fan shall operate at high speed when kitchen exhaust fans EF-1 is proven on or if dining area zone exceeds setpoint by 1 degrees (adj). The supply fan shall maintain setpoint determined by balancing contractor (adjustable).

Supply Fan Monitoring: The DDC system shall monitor the supply fan through a current sensing relay.

Discharge Air Temperature Control:

Cooling Coil and Reheat Coil shall modulate to maintain space temperature. Supply air temperature to reset between 55 and 85 (adj) based on dining room zone temperature.

Discharge Air Temperature PID:
Discharge air temperature shall be controlled to supply air temperature set point using a control loop whose output is mapped to sequence the economizer and cooling coil. The loop shall be biased such that it starts calculating with the cooling coil valve closed

Return Fan
Return fan (RF-2) shall modulate to maintain return duct pressure.

Exhaust Fan Control EF-1
BMS schedule for fan availability 4AM (adj) to 3PM (adj). When fan is available Exhaust fan is controlled by a timer switch (2-3 duration)

Kitchen Make-up Air Dampers

Kitchen Make-up Air dampers shall monitor hood status. When EF-1 is proven on the Kitchen Make-up Air damper shall open 100% (adj). When EF-1 is proven off kitchen make up air damper shall close 0% (adj).

Return Air Damper

Return air damper shall be 100% (adj) open when kitchen make-up air damper is closed. When kitchen make up air damper is open return air damper shall adjust to position set by balancer (adj)

Ventilation Damper with free cooling function

Free Cooling shall be disabled whenever the outside air dry bulb temperature is above 62°F (adj). In this case the make-up air VAV is controlled to ventilation flow setpoint. When free cooling is enabled the VAV shall modulate between ventilation flow and maximum economizer flow as commanded by the

output of the discharge air temperature PID. The VAV is commanded to ventilation flow rate when free cooling is disabled, and closed when the schedule is unoccupied, or when the unit is off, or when free cooling is disabled, or when any safety is tripped.

VAV min position is Ventilation air quantity. VAV to modulate up for cooling purposes under free cooling conditions. VAV max has two conditions based on supply fan speed (2850 CFM and 5700 CFM)

MULTIPLE-ZONE VAV AIR HANDLING UNIT (AHU-14)

Overview:

This variable volume air handler serves terminal units with reheat.

The unit is provided with (1) modulating supply fans, a modulating return fan, hot water preheat and chilled water coils, a ventilation air DX coil, modulating economizer, return air, and relief air dampers, and filters.

Temperature is reset based on zone demand.

The economizer damper modulates to maintain discharge air temperature at setpoint when enabled.

The relief air damper modulates to maintain building pressure setpoint.

The supply fans modulate to maintain discharge pressure setpoint (adj).

The return fan modulates to maintain return air pressure setpoint (adj) .

The unit sends plant enable and pressure reset requests to the cooling and heating plants based on discharge temperature and valve position.

Safeties:

Freeze Stat Trip / Preheat Discharge Air Temperature drops below 40° F (TL-PHC): Shut off AHU, close outside air damper, preheat valve & pump remains enabled and modulates to maintain 50 degree preheat leaving coil temperature.

Supply Air pressure High Limit (PHL-SA)

Return Air Pressure High Limit (PHL-RA)

Alarms

Supply Fan status (AL-SF) doesn't match fan command = Shut off AHU, close Outside air damper, preheat valve & pump remains enabled and modulates to maintain discharge temperature setpoint, and open chilled water valve 100%.

Return fan status (AL-RF) doesn't match fan command = Alarm to notify maintenance Staff

Status of Pre-heat Pump = doesn't match pump command = Shut off AHU, close Outside air damper, preheat valve & pump remains enabled and modulates to maintain discharge temperature setpoint,

Schedule:

See "Zone Groups" for scheduling.

Set-point Reset Logic

Set-point reset logic and zone/system reset requests, where referenced in sequences, shall be implemented as described below.

Discharge Air Static Pressure Setpoint:

Supply fan to maintain user set setpoint 1.2" w.c. (adj)

Ventilation Air DX Coil Control:

When the unit is enabled and O.A. temp is above 60 (adj) degrees the DX coil shall modulate to maintain 52 (adj) T-VA temperature. If the fan status is OFF or the outside air temperature is below 58°F (adj) the valve is locked out.

Chilled Water Valve Control:

As the discharge temperature control loop output goes from 51% to 100%, the valve is commanded from 0% to 100%.

If the fan status is OFF or the outside air temperature is below 54°F the valve is locked out.

Pre-heat Coil Water Valve Control:

The valve modulates together with the cooling valve to maintain discharge air temperature when the fan is proved ON and the economizer is inactive.

As the discharge temperature control loop output goes from 0% to 50%, the valve is commanded from 100% to 0%. If the unit is economizing, the valve is locked out.

Chilled Water Pressure Reset Request:

If the supply air temperature exceeds the supply air temperature set point by 5°F for 2 minutes, send 3 requests.

Else if the supply air temperature exceeds the supply air temperature set point by 3°F for 2 minutes, send 2 requests.

Else if the CHW valve position is greater than 95%, send 1 request until the CHW valve position is less than 85%.

Else if the CHW valve position is less than 95%, send 0 requests.

Call for Cooling:

Send the chiller plant that serves the system a chiller plant request as follows:

If the CHW valve position is greater than 95%, send 1 request until the CHW valve position is less than 10%.

Else if the CHW valve position is less than 95%, send 0 requests.

The chiller plant will start when there is at least one request for 5 minutes, and stop when there are no requests for 5 minutes, after a minimum run-time has elapsed.

Actuation of the chilled water valve resulting from a low limit / freeze stat safety shall not produce a call for cooling request. However, this condition shall result in the enabling of a chilled water system pump to circulate water. See the chilled water plant pump control sequence.

Hot Water Pressure Reset Request:

If the supply air temperature is 30°F less than set point for 5 minutes, send 3 requests.

Else if the supply air temperature is 15°F less than set point for 5 minutes, send 2 requests.

Else if HW valve position is greater than 95%, send 1 request until the HW valve position is less than 85%.

Else if the HW valve position is less than 95%, send 0 requests.

Call for Heating:

Send the heating hot-water plant that serves the AHU a heating hot-water plant request as follows:

If the HW valve position is greater than 95%, send 1 request until the HW valve position is less than 10%.

Else if the HW valve position is less than 95%, send 0 requests.
The hot water plant will start when there is at least one request for 5 minutes, and stop when there are no requests for 5 minutes, after a minimum run-time has elapsed

Return fan speed:

Upon proof the of supply fan status, the return fan shall enable and modulate between minimum speed initially set at 0% and maximum speed initially set at 100% to maintain the return air pressure set point to a positive pressure initially set at .15" W.C. (adj)

Economizer Damper Control:

Economizer shall be disabled whenever the outside air dry bulb temperature is above 62°F (adj) or the outside air dewpoint temperature is above 55°F.The damper is commanded closed when the schedule is unoccupied, or when the unit is off, or when economizer is disabled, or when the heating valve is open, or when any safety is tripped. When enabled the damper modulates from 0% to 100% as commanded by the output of the discharge air temperature PID.

Return Air Damper Control:

When the unit is enabled and economizer disabled the return damper is commanded to 100% (adj) open. When the economizer is enabled the return damper shall track opposite of economizer damper.

Relief Air Damper Control:

When the unit is enabled the relief air damper modulates to maintain building pressure setpoint (.008" W.C. adj).

Preheat Coil Pump Control:

The pump is enabled when the preheat valve is more than 5% open or when the outside air temperature is below 40°F and disabled when the valve is closed and the outside air temperature is above 42°F.
In the event of a Freezestat, the pump is commanded to start.

Existing Electric Baseboard Heaters

Disable electric baseboard heaters serving the 14th floor when O.A. temperature is above 70 degrees.
Enable electric baseboard heaters when O.A. temperature is below 65 Degrees.

Graphics:

All graphics shall display time of day, date, outdoor air temperature and outdoor air relative humidity.

Air Handling System Graphics:
System graphics shall show number of incoming heating and cooling requests, pressure reset requests, total VAV flow, total VAV flow setpoint, Max VAV damper position, and Min VAV damper position,

VAV Graphics:
All VAV graphics shall include room name and number, and a link to the RTU which serves the VAV.

Air Handling Unit Summary Table:
A summary table shall include a list of all air handling equipment. Columns shall include fan status, fan speed, static pressures, discharge temperature, valve and damper positions.

VAV Summary Table:
A summary table for each air handling system shall include a list of all VAVs served by the system. Columns shall include air flow, air flow setpoint, damper position, supply temperature, valve position, zone temperature, and zone temperature setpoint. Provide a slider lockout at the summary table and shown on graphics with the ability to switch from BMS to room control. Room control to remain within the slider range when activated.

HEATING PLANT SYSTEM

Overview:
The heating plant consists of two variable speed pumps and two steam to hot water heat exchangers piped in a vari-prime configuration. The pumps and heat exchanges are selected with redundant capacity, only one pump and one heat exchanger are required to run at a time.
The plant is enabled when any valve opens. Pressure is reset based on valve position and temperature is maintained constant. A flow meter and two temperature sensors are used to calculate energy consumption. A Steam pressure sensor indicates when steam is available on the heating plant graphics.

Safeties:
The loop is fitted with mechanical pressure relief valves.
Startup/Shutdown:
The plant is enabled if any valve is open and disabled if all valves are closed.
HX and Pump Duty Cycle:
Heating Water Temperature Control:
The setpoint is set based on an outdoor air reset.

Outside Air Temp	Heating Water Supply Temperature
10 deg	140 Deg
60 Deg	120 Deg

The enabled heat exchanger modulates its steam valve to maintain temperature setpoint.

Heating Water Pressure Control:
Differential Pressure Setpoint: The pressure setpoint is reset between 5psi (adj) and 20psi (adj) to maintain the maximum heating valve position at 85%.
Plant Differential Pressure Control: The operating pump modulates from 30% speed to 100% speed in order to maintain the calculated pressure setpoint.
HX Control:

Duty Cycle: Provide an operator selector for selecting the lead heat exchanger. Total runtime for each device is tallied, an alarm to nofity the operator that the heat exchanger switch order of lead/lag HX's. Alarm shall indicate after 1000hrs (adj) of run time.
Isolation Control: Each heat exchanger is fitted with an isolation valve and a steam modulation valve. When a unit is disabled, both valves are commanded closed. When the plant is enabled, the unit with the least amount of hours opens its isolation valve.
When the units switch operation for duty cycle, the running unit will wait 90 seconds to close its valves in order to allow startup of the idle unit.
Steam Valve Control: When the unit is enabled, the steam valve modulates to maintain heating water temperature. When the units switch operation for duty loading, both valves control to the same signal. After the idle unit has been running for 90 seconds, the running unit is disabled and the steam valve closes.
HX Failure: If a heat exchanger is enabled and the hot water temperature is 10°F (adj) below setpoint for 5 minutes (adj), the idle unit will be enabled and latched until the failed unit is cleared by the operator.

Heating Water Pump Control:
Duty Cycle: Total runtime for each device is tallied, the pumps are rotated every 200 hours to render equal runtime.
Pump Enable: The pump with the least number of hours is enabled when the plant is enabled. When the running pump has accumulated 200 hours more than the idle pump, the idle pump will be enabled, after 90 seconds the running pump is disabled.
Pump Speed Control: When the pump is enabled, speed modulates to maintain system pressure. During the 90 seconds that both pumps are on for the duty cycle switchover, both pumps are commanded to the same speed.
Pump Failure: In the event that a pump is commanded on and no status is received for 5 seconds, the idle pump will be enabled and latched until the failed pump is cleared by the operator.
Alarms:
HX Failure: Plant has been enabled for 30 minutes and loop temperature is 10°F below setpoint for 5 minutes.
Pump Failure: A pump is commanded on and no status is received for 5 seconds.

CHILLED WATER SYSTEM

Overview:
The chilled water plant consists of two variable speed pumps and two chilled water heat exchangers piped in a vari-prime configuration with an additional heat exchanger and dry cooler for free cooling See dry cooler section for switch over sequence and setpoints. The pumps are selected with redundant capacity, only one pump and one is required to run at a time, but staged for efficiency. The plant is enabled when any valve opens. Pressure is reset based on valve position and temperature is maintained constant.

A flow meter and two temperature sensors are used to calculate energy consumption.
Safeties:
The loop is fitted with mechanical pressure relief valves.
Startup/Shutdown:
The plant is enabled if any valve is open and disabled if all valves are closed.
Chilled Water Temperature Control:
The setpoint is set to constant 47.5°F (adj). The enabled heat exchanger modulates its control valve to maintain temperature setpoint.
Chilled Water Pressure Control:
Differential Pressure Setpoint: The pressure setpoint is reset between 7 psi and 12 psi to maintain the maximum cooling valve position at 85%.
Plant Differential Pressure Control: The operating pump modulates from 30% speed to 100% speed in

order to maintain the calculated pressure setpoint.

HX Control:

Duty Cycle: Total runtime for each device is tallied, the lead heat exchanger is rotated every 400 hours (adj)to render equal runtime.
Isolation Control: Each heat exchanger is fitted with a secondary and tertiary modulating control valve. When a unit is disabled, both valves are commanded closed. When the plant is enabled, the unit with the least amount of hours opens its tertiary isolation valve, and the secondary control valve modulates to maintain temperature.
When the units switch operation for duty cycle, the running unit will wait 90 seconds to close its valves in order to allow startup of the idle unit.
When the dry cooler is in cooling mode the primary chilled water HX's (HX-3, HX-4) or disabled.
HX Failure: If a heat exchanger is enabled and the chilled water temperature is 6°F (adj) above setpoint for 5 minutes, the idle unit will be enabled and latched until the failed unit is cleared by the operator.

Chilled Water Pump Control:

Duty Cycle: Total runtime for each device is tallied, the lead pumps are rotated every 400 hours to render equal runtime. When the lead pump exceeds 70% speed the lag pump is engaged.
Pump Enable: The pump with the least number of hours is enabled when the plant is enabled. When the running pump has accumulated 400 hours more than the idle pump, the idle pump will be enabled, after 90 seconds the running pump is disabled.
Pump Speed Control: When the pump is enabled, speed modulates to maintain system pressure. During the 90 seconds that both pumps are on for the duty cycle switchover, both pumps are commanded to the same speed.
Pump Failure: In the event that a pump is commanded on and no status is received for 5 seconds, the idle pump will be enabled and latched until the failed pump is cleared by the operator.

Alarms:

HX Failure: Plant has been enabled for 30 minutes and loop temperature is 6°F (adj) above setpoint for 5 minutes.
Pump Failure: A pump is commanded on and no status is received for 5 seconds.

Dry Cooler:

The dry cooler serves for free cooling in the winter and provides supplemental heat in the summer. The system consist of a dry cooler w/ variable speed fans, plate and frame heat exchanger in side car configuration, a glycol loop pump, load side pump, change over valves and temperature sensors.

Chilled water mode shall be enabled below 55 degrees O.A. (adj).

Upon cooling command enable Pumps PHX-2, and DCP-1, open CV-3 and CV-3A, modulate dry cooler fan to maintain set point based on the outdoor air reset schedule below.

Outside Air Temp	Chilled Water Supply Temperature
55 deg (adj)	60 Deg (adj)
40 Deg (adj)	45 Deg (adj)

Heating water mode shall be enabled above 80 degrees O.A. (adj).

Upon heating command enable Pumps PHX-2, and DCP-1, open CV-4 and CV-4A, modulate dry cooler

fan to maintain set point based on the outdoor air reset schedule below.

Outside Air Temp	Heating Water Supply Temperature
80 deg (adj)	75 Deg (adj)
100 Deg (adj)	95 Deg (adj)

End of Section 230900

SECTION 232113 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 200800 “Seismic Protection,” Section 230100 “Basic Mechanical Requirements,” and Section 230500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Makeup-water piping.
4. Condensate-drain piping.
5. Blowdown-drain piping.
6. Air-vent piping.
7. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:

1. Division 07 Section “Penetration Firestopping” for materials and methods for sealing pipe penetrations through fire and smoke barriers.
2. Division 07 Section “Joint Sealants” for materials and methods for sealing pipe penetrations through exterior walls.
3. Division 23 Section “Basic Mechanical Materials and Methods” for general piping materials and installation requirements, and for labeling and identifying hydronic piping.
4. Division 23 Section “Hangers and Supports” for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
5. Division 23 Section “Valves” for general-duty gate, globe, ball, butterfly, and check valves.
6. Division 23 Section “Meters and Gages” for thermometers, flow meters, and pressure gages.

7. Division 23 Section “Hydronic Pumps” for pumps, motors, and accessories for hydronic piping.

8. Division 23 Section “Control Systems” for temperature-control valves and sensors.

1.3 DEFINITIONS

A. CWP: Cold working pressure (formerly WOG – Water, Oil, Gas working pressure).

B. DZR Brass: Brass alloy containing not more than 15% zinc by weight.

C. SWP: Steam working pressure.

D. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

E. Class 125: Minimum 125-psig (860-kPa) SWP and minimum 200-psig (1380-kPa) CWP ratings.

F. Class 150: Minimum 150-psig (1035-kPa) SWP and minimum 300-psig (2070-kPa) CWP ratings.

1.4 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: 150 psig at 200ºF.

2. Chilled-Water Piping: 150 psig at 200ºF.

3. Makeup-Water Piping: 80 psig at 150ºF.

4. Condensate-Drain Piping: 150ºF.

5. Blowdown-Drain Piping: 200ºF.

6. Air-Vent Piping: 200ºF.

7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Plastic pipe and fittings with solvent cement.

2. Valves. Include flow and pressure drop curves based on manufacturer’s testing for calibrated-orifice balancing valves and automatic flow-control valves.

3. Air control devices.

4. Hydronic specialties.

B. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, “Structural Welding Code - Steel.”

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, “Code for Pressure Piping.”

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, “Building Services Piping,” for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air/dirt separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Comply with NFPA 70 – National Electrical Code. Do not route piping directly above electric panelboards and switchboards, or other prohibited locations.

1.7 COORDINATION

A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate pipe sleeve installations for foundation wall penetrations.

C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 07 Sections.

D. Coordinate pipe fitting pressure classes with products specified in related Sections.

E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03 Sections.

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 07 Section “Penetration Firestopping” for fire and smoke wall and floor assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Manual Balancing Valves:

    a. Armstrong Pumps, Inc.
    b. “Circuit Setter” by Bell & Gossett; a Xylem Brand.
    c. Nexus Valve.
    d. Nibco Inc.
    e. Tour & Andersson.

2. Pressure-Reducing Valves and Safety Valves:

    a. Amtrol, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett; a Xylem Brand.
    d. Conbraco Industries, Inc.
    e. Spence Engineering Company, Inc.
    f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

3. Manual, Expansion Tanks, Air Purgers:

    a. Amtrol, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett; a Xylem Brand.

4. Automatic Air Vents and Coalescing-type Air/Dirt Separators:

    a. Spirotherm, Inc. or approved equal.

5. Strainers:

    a. Armstrong Machine Works.Eaton Filtration.
    b. Hoffman Specialty ITT; Fluid Handling Div.
    c. Metraflex Co.
    d. Nibco Inc.
    e. Spirax Sarco.
    f. Watts Regulator Co.

2.2 PIPING MATERIALS

A. General: Refer to Part 3 “Piping Applications” Article for applications of pipe and fitting materials, including a schedule of which types of piping to use in which application.

2.3 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B88, Type L (ASTM B88M, Type B).

B. Annealed-Temper Copper Tubing: ASTM B88, Type K (ASTM B88M, Type A).

C. DWV Copper Tubing: ASTM B306, Type DWV.

D. Wrought-Copper Fittings: ASME B16.22.

E. Wrought-Copper Unions: ASME B16.22.

F. Solder Filler Metals: ASTM B32, 95-5 tin antimony.

G. Field or shop fabricated fittings are not allowed. Pulled-tees or pipe fittings using “T-Drill” are not allowed.

2.4 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; Type E (Electric-resistance welded), Grade B, Schedule 40; unless otherwise indicated in Part 3 “Piping Applications” Article.

B. Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M black steel, Grade B, Schedule 40; unless otherwise indicated in Part 3 “Piping Applications” Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150 or 300 as indicated in Part 3 “Piping Applications” Article.

D. Malleable-Iron Unions: ASME B16.39; Class 150, 250, or 300 as indicated in Part 3 “Piping Applications” Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Class 125 or 250 as indicated in Part 3 “Piping Applications” Article; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe. All elbows shall be long-radius type.

G. Wrought Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.

2. End Connections: Butt welding.

3. Facings: Raised face.

2.5 SPECIALTIES

A. Refer to Division 23 Section “Basic Mechanical Materials and Methods” for joining materials, transition fittings, and dielectric fittings. Those requirements apply to the work of this Section as if fully reproduced herein.

2.6 GENERAL-PURPOSE VALVES

A. Refer to Division 23 Section “Valves” for Gate, Globe, Check, Ball, and Butterfly Valves, whose requirements apply to the work of this Section as if fully reproduced herein.

B. Refer to Division 23 Section “Control Systems” for Automatic Temperature-Control Valves, Actuators, and Sensors, whose requirements apply to the work of this Section as if fully reproduced herein.

C. Refer to Part 3 “Valve Applications” Article elsewhere within this Section for applications of each type of valve and service.

2.7 SPECIALTY VALVES

A. Calibrated-Orifice Balancing Valves:

1. Body (Size 2-inch NPS and smaller): Bronze or DZR-brass body; ball- or plug-type with calibrated orifice or venturi.

2. Body (Size 2½-inch NPS and larger): Cast-iron or steel body; ball, plug, or globe pattern with calibrated orifice or venturi.

3. Ball: Brass or stainless steel.

4. Plug: Resin.

5. Seat: PTFE.

6. Stem Seals: EPDM O-rings.

7. Disc: Glass and carbon-filled PTFE.

8. End Connections (Size 2-inch NPS and smaller): Threaded or socket.

9. End Connections (Size 2½-inch NPS and larger): Flanged.

10. Pressure Gage Connections: Integral seals for portable differential pressure meter.

11. Handle Style: Lever, with memory stop to retain set position.

12. Accessories: Integral pointer and calibrated scale to register degree of valve opening.

13. CWP Rating: Minimum 125 psig (860 kPa).

14. Maximum Operating Temperature: 250ºF (121 C).

B. Diaphragm-Operated Pressure-Reducing Valves:

1. Body: Bronze or DZR-brass.

2. Disc: Glass and carbon-filled PTFE.

3. Seat: Brass.

4. Stem Seals: EPDM O-rings.

5. Diaphragm: EPT.

6. Low inlet-pressure check valve.

7. Inlet Strainer: Bronze or stainless steel; removable without system shutdown.

8. Valve Seat and Stem: Noncorrosive.

9. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

C. Diaphragm-Operated Safety Valves:

1. Body: Bronze or DZR-brass.

2. Disc: Glass and carbon-filled PTFE.

3. Seat: Brass.

4. Stem Seals: EPDM O-rings.

5. Diaphragm: EPT.

6. Wetted, Internal Work Parts: Brass and rubber.

7. Inlet Strainer: Bronze or stainless steel; removable without system shutdown.

8. Valve Seat and Stem: Noncorrosive.

9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.8 AIR CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.

2. Internal Parts: Nonferrous.

3. Operator: Manual via screwdriver or thumbscrew.

4. Inlet Connection: NPS ½ (DN 15).

5. Discharge Connection: NPS 1/8 (DN 6).

6. CWP Rating: 150 psig (1035 kPa).

7. Maximum Operating Temperature: 225ºF (107 C).

B. Automatic Air Vents shall be Spirotherm Spirotop Air Release Valve.

C. Diaphragm or Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 240ºF (115 C) maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Diaphragm or Bladder (as indicated on Drawings; Diaphragm if not indicated): Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.9 COALESCING-TYPE AIR/DIRT SEPARATORS

A. Tank: Welded steel; ASME constructed and labeled for 125-psig (860-kPa) working pressure and 240ºF (115 C) operating temperature.

B. Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2½ (DN 65) and larger. Designed for inline connection, with inlet and outlet connections aligned on a common horizontal axis.

C. Blowdown Connection: Threaded, valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

D. Size: Match system flow capacity. Include appropriate reducers to connect to piping as shown on the drawing.

E. Medium: Integral copper tube-and-mesh assembly to act as the turbulence suppressive coalescing and barrier medium, which must completely fill the separators internal area. Separators shall remove free and entrained air during system operation and continue to eliminate dissolved air and dirt through constant circulation and the coalescing / barrier action of the tubes.

   1. Internal coalescing elements consisting of plastic, perforated steel plate or tubes, or randomly-filled loose steel rings will not be accepted.

F. Venting Chamber: Prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral float actuated brass air vent. There shall be no restriction in the connection from the venting chamber to the vent.

G. Lower Chamber: Vessel shall extend below the pipe connections for dirt separation. The internal medium shall act as a barrier to force dirt and sediment to fall from the flow path to a collection chamber for blowdown through standard connection and valve.

H. Performance: Coalescing air-and-dirt separator shall remove 100% of the entrained air, 100% of the free air, and 99% of the dissolved air from the system fluid; and shall remove at least 80% of all particles 30 micron and larger within 100 passes. Separator must be capable of removing particles down to 5 microns. This performance shall be certified by a reputable, independent, third-party testing laboratory, proof of which shall be submitted in writing as part of the submittal process, including name of laboratory, location, date of test, and test results.

I. Removable head, to facilitate removal of tube assembly for inspection or cleaning.

2.10 CHEMICAL TREATMENT

A. Bypass Chemical Feeder: Welded steel construction; 125-psig (860-kPa) working pressure; 5-gal. (19-L) capacity; with fill funnel and inlet, outlet, and drain valves.

B. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

2.11 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers, 2-inch and Smaller:

1. Body (for use in Copper piping): ASTM B584 C84400 or ASTM B-62 C83600 bronze body, with threaded bronze cover and brass drain plug.

2. Body (for use in Steel piping): ASTM A126, Class B, cast iron with threaded cap and bottom drain connection.

3. End Connections: Threaded ends.

4. Strainer Screen: 20-mesh, Type 304 stainless steel.

5. CWP Rating: 200 psig (1380 kPa) at 150ºF (65 C).

6. SWP Rating: 150 psig (1030 kPa) at 350ºF (176 C).

B. Y-Pattern Strainers, 2½-inch and Larger:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Flanged ends.

3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 175 psig (1200 kPa) at 150ºF (65 C).

5. SWP Rating: 125 psig (860 kPa) at 350ºF (176 C).

C. Refer to Division 23 Section “Pipe Expansion Fittings” for expansion fittings and loops, whose requirements apply to the work of this Section as if fully reproduced herein.

D. Refer to Division 23 Section “Basic Mechanical Materials and Methods” for flexible pipe connectors, whose requirements apply to the work of this Section as if fully reproduced herein.

PART 3 - EXECUTION

3.1 PIPING SCHEDULE OF APPLICATIONS

A. Hot-water heating piping, Chilled-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be Type L (C), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

1. Contractor’s Option: Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints will be acceptable.

B. Hot-water heating piping, Chilled-water piping, aboveground, NPS 2½ (DN 65) and larger, shall be Standard Weight schedule 40 steel pipe; wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. All elbows shall be long-radius type.

C. Makeup-water piping installed aboveground shall be Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Cooling Coil Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints;

E. Heat exchanger or other hydronic heating system drains (blowdown, overflow, etc.): Use same materials and joining methods as for hot-water heating piping described above.

F. Air-Vent Piping: Same materials and joining methods as for piping specified for the service in which air vent is installed.

G. Safety-Valve-Inlet and -Outlet Piping for HVAC Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

H. Other HVAC-Related Piping Applications:

1. Chemical Treatment Piping: Type L (C), drawn-temper copper tubing, wrought-copper fittings, and soldered joints, or Schedule 40 PVC plastic pipe and fittings and solvent-cemented joints, as recommended by chemical treatment provider.

I. Contractor's Option: Standard Weight steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints will be acceptable where welded-steel piping is specified above, but only where piping is exposed to view or located above a fully-accessible lay-in ceiling.

3.2 VALVE APPLICATIONS

A. Install valves where indicated on Drawings and where indicated in Division 23 Section "Valves."

B. Install safety valves at heat exchangers and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

C. Install specialty valves where indicated on Drawings.

D. Install drain valves at all low points, and manual air vents at all high points, in mains, risers, branch lines and elsewhere as required for system drainage.

E. Any valve that represents a termination or the end of a run (e.g., blowdown or drain valve, hose-end valve, etc.) shall be fitted with a permanent but removable cap, plug, or blind flange matching the valve construction, to minimize risk in the event the valve is accidentally opened under pressure.

F. Route automatic air vent discharge in ¼ inch (6.4 mm) poly tubing to floor drain.

3.3 PIPING INSTALLATIONS

A. General: General piping installation is specified in Division 23 Section "Basic Mechanical Materials and Methods," whose requirements apply to the work of this Section as if fully repeated herein.

B. Install drains, consisting of a tee fitting, NPS ¾ (DN 20) ball valve, and short NPS ¾ (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

C. In closed systems, install horizontal piping at a uniform grade of 0.2 percent upward in direction of flow.

D. For cooling coil condensate-drain piping, install horizontal piping at a uniform grade of 1.0 percent downward in the direction of flow.

E. Bull-head tees prohibited: Do not use tee fittings in such a way that the flow through the branch leg equals the sum of the flows through two main legs.

F. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

G. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the top of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

H. Changes of direction, branches, tees, etc. shall be accomplished with the appropriate factory or foundry fitting meeting the requirements of these specifications. Mechanically-formed extruded tee outlets or field-fabricated tee branches and/or elbows are not acceptable.

I. All elbows shall be long-radius type.

J. Install valves according to Division 23 Section “Valves.”

K. Install unions in piping NPS 2 (DN 50) and smaller, at final connections of equipment and elsewhere as indicated.

L. Install flanges in piping NPS 2½ (DN 65) and larger, at final connections of equipment and elsewhere as indicated.

M. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS ¾ (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).

N. Install and anchor piping to allow for proper length and direction of expansion and contraction.

O. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

P. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

Q. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

R. Install expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section “Pipe Expansion Fittings.”

S. Identify piping as specified in Division 23 Section “Basic Mechanical Materials and Methods.”

T. Hang, support, and anchor all piping as specified in Division 23 Section “Hangers and Supports.”

U. Restrain all piping against seismic forces as specified in Division 20 Section “Seismic Protection.”

V. Connect copper branch lines to steel or iron mains as follows: Install steel branch pipe off main with black iron nipple connected to bronze ball valve. Connect bronze ball valve to copper piping with threaded copper male adaptor, which is then soldered to the copper branch line.

W. Provide shutoff valves at each floor and/or branch on hot water reheat systems.

3.4 PIPE JOINT CONSTRUCTION

A. Refer to Division 23 Section “Basic Mechanical Materials and Methods” for joint construction requirements for soldered joints in copper tubing; threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC piping.

B. Welded Joints: Construct joints according to AWS D10.12, “Recommended Practices and Procedures for Welding Low Carbon Steel Pipe,” using qualified processes and welding operators according to “Quality Assurance” Article.

1. Apply one coat of self-priming, rust-inhibitor paint around the entire circumference of each welded pipe joint; regardless of whether or not the piping is specified to be painted. Paint may be brush-applied, roller-applied, or spray-applied at contractor’s option.

3.5 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install ball valve at all locations were a manual air vent is installed as indicated on Drawings.

C. Install automatic air vents where indicated on Drawings.

D. Install air/dirt separator in pump suction, unless another location is indicated on Drawings. Install blowdown piping with full-port ball valve; extend full size to nearest floor drain.

E. Install expansion tanks at location indicated on Drawings. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.

2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

3. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

F. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches (1200 mm) above the floor. Install feeder in minimum NPS ¾ (DN 20) bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS ¾ (DN 20) pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

G. Install simplex basket strainers at location indicated on Drawings. Install line size shutoff valves on inlet, outlet and bypass around strainer.

1. Install strainer fittings that are shipped loose.

2. Support strainer from floor on concrete housekeeping pad.

3. Coordinate installation of strainer to allow removal of strainer out the top of unit.

4. Strainer shall be located on the chilled water supply between the building entrance and building pump.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment, but outside the service area. For example, control valve shall be as close to hydronic coil as practical, but not within the coil pull space and/or access door swing space.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section “Meters and Gages.”

3.7 CHEMICAL TREATMENT

A. Water treatment scope to be provided by Walter Louis Fluid Technologies. Water treatment scope to be carried in the contractors bid.

B. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:

1. pH: 9.0 to 10.5.

2. “P” Alkalinity: 100 to 500 ppm.

3. Boron: 100 to 200 ppm.

4. Chemical Oxygen Demand: Maximum 100 ppm. Modify this value if closed system contains glycol.

5. Corrosion Inhibitor: Sodium Nitrate Plus Molybdate, 100 to 200 ppm each.

6. Soluble Copper: Maximum 0.20 ppm.

7. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.

8. Total Suspended Solids: Maximum 10 ppm.

9. Ammonia: Maximum 20 ppm.

10. Free Caustic Alkalinity: Maximum 20 ppm.

11. Microbiological Limits:

    a. Total Aerobic Plate Count: Maximum 1000 organisms/ml.
    b. Total Anaerobic Plate Count: Maximum 100 organisms/ml.
    c. Nitrate Reducers: 100 organisms/ml.
    d. Sulfate Reducers: 0 organisms/ml.
    e. Iron Bacteria: 0 organisms/ml.

C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Notify Owners Representative 72 hours before required testing. All tests shall be conducted in the presence of the Owner Representative.

2. Leave joints, including welds, uninsulated and exposed for examination during test.

3. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

4. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

5. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

6. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used. Do not pressure test with air.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. Minimum duration of test shall be four (4) hours. During the final hour of the hydrostatic test, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

7. Minimum test pressure shall be 100 PSIG.

8. Calibrate all pressure gauges within one year of test date.

C. Perform the following before operating the system:

1. Open manual valves fully.

2. Inspect pumps for proper rotation.

3. Set makeup pressure-reducing valves for required system pressure.

4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

5. Set temperature controls so all coils are calling for full flow.

6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.

7. Verify lubrication of motors and bearings.

D. System shall be operational for a minimum of 24 hours to demonstrate to the Owner's Representative that system is complete and operational.

3.9 CLEANING AND ADJUSTING

A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

END OF SECTION 232113

SECTION 232123 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 230800 “Seismic Protection,” Section 230100 “Basic Mechanical Requirements” and Section 230500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes the following:

1. Separately coupled, base-mounted, end-suction centrifugal pumps.

2. Inline centrifugal pumps.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 23 Section “Meters and Gages” for thermometers and pressure gages, connector plugs, and devices.

2. Division 23 Section “Motors” for pump motors.

3. Division 23 Section “Mechanical Vibration Isolation” for spring supports, and spring hangers.

4. Division 23 Section “Control Systems” for interlock wiring between pumps, and between pumps and field-installed control devices.

5. Division 26 Sections for power-supply wiring, field-installed disconnects, required electrical devices, and motor controllers.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

C. HI: Hydraulic Institute.

1.4 SUBMITTALS

A. General: Follow the procedures specified in Division 01 Section “Special Conditions.”

B. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

C. Wiring Diagrams: Detail wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.

D. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals specified in Division 01.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific "basis of design" system indicated. Refer to Division 23 Section "Basic Mechanical Requirements" for use of products other than the "basis of design."

C. Published pump performance (flow and head delivered) shall be determined by factory-testing per ANSI/HI 14.6 *Rotodynamic Pumps for Hydraulic Performance Acceptance Tests*.

D. Regulatory Requirements: Comply with provisions of the following:

1. ASME B31.9 "Building Services Piping" for piping materials and installation.

2. Hydraulic Institute's "Standards for Centrifugal, Rotary & Reciprocating Pumps" for pump design, manufacture, testing, and installation.

3. UL 778 "Standard for Motor Operated Water Pumps" for construction requirements. Include UL listing and labeling.

4. NEMA MG 1 "Standard for Motors and Generators" for electric motors. Include NEMA listing and labeling.

5. NFPA 70 "National Electrical Code" for electrical components and installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Extended Storage Longer than 5 Days: Dry internal parts with hot air or vacuum-producing device. Coat internal parts with light oil, kerosene, or antifreeze after drying. Dismantle bearings and couplings; dry; coat with acid-free, heavy oil; tag; and store in dry location.

D. Retain protective covers for flanges and protective coatings during storage. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 EXTRA MATERIALS

A. Furnish one extra mechanical seal for each pump that matches products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 PUMPS, GENERAL (APPLIES TO ALL TYPES OF HYDRONIC PUMPS)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong Pumps Inc.
2. Bell & Gossett; a Xylem Brand.
3. ITT Goulds Pumps.

B. Motors: NEMA MG 1, general purpose, continuous duty, Design B, except Design C where required for high starting torque. Furnish single-speed motors, with type of enclosures and electrical characteristics indicated. Include grease-lubricated ball bearings. Select each motor to be non-overloading over full range of pump performance curve. Motors shall be high efficiency, premium quality, secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section “Motors,” whose requirements apply to the work of this Section as if fully reproduced herein.

1. Provide inverter-ready motors where variable speed drives are indicated.

C. Factory Finish: Manufacturer’s standard paint applied to factory-assembled and -tested units before shipping.

D. Manufacturer’s Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

E. Operating Speed: Do not exceed 1800 rpm unless expressly scheduled on the Drawings.

2.2 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Separately-Coupled, Base-Mounted End-Suction Pumps: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig (1204-kPa) minimum working pressure and a continuous water temperature of 225ºF (107 C).

B. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections.

1. Provide integrally-cast feet on volute to support the casing and attached piping, such that volute remains rigidly attached to the pump base when motor and shaft are removed.

2. Provide true back pull-out design to allow removal and replacement of impeller and/or seals without disconnecting piping or motor, nor requiring the realignment of pump and motor shaft.

C. Flanges: ASME B16.1 Class 125.

D. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.

E. Impeller Shaft: Solid 416 or 420 stainless steel construction heat-treated to 80 KSI yield strength.

F. Shaft sleeve: Copper-alloy.

G. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N or EPT bellows and gasket; split seal.

H. Wear Rings: Replaceable, bronze, ASTM B584-932 SAE660, casing ring.

I. Pump Bearings: Permanently grease-lubricated ball bearings contained in cast-iron housing with grease fittings. Bearings shall be capable of absorbing both radial and thrust loads and maintaining the rotating element in proper axial alignment. Bearings shall be capable of being inspected and repaired by removal of only a bearing bracket.

J. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration, including removable metal coupling guard.

1. Provide EPDM or neoprene coupling sleeve for variable-speed applications.

2. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor.

3. Coupling shall be “Dura-Flex” HP as manufactured by TB Woods. No substitutions are allowed.

K. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

L. Mounting Frame: Baseplate shall be constructed of structural steel or fabricated steel channels with fully-enclosed sides and ends, full-seam welds, and welded cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor. Minimum baseplate stiffness shall conform to ANSI/HI 1.3.4-1997 “Horizontal Baseplate Design” standards. Grind all welds smooth prior to application of finish. Base shall include an integral drain pan with ¾” drain connection to collect condensate and seal leakage.

2.3 INLINE CENTRIFUGAL PUMPS

A. Inline Pump: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, inline pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor

shafts mounted horizontally only. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225ºF.

B. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.

C. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.

D. Pump Shaft: Steel, with bronze or copper-alloy shaft sleeve. A stainless steel shaft is also acceptable.

E. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N or EPT bellows and gasket. Include water slinger on shaft between motor and seal.

F. Pump Bearings: Permanently lubricated ball bearings; or oil-lubricated bronze-journal or thrust type.

G. Wear Rings: Replaceable, bronze casing ring.

H. Shaft and Sleeve: Ground and polished stainless-steel shaft with bronze sleeve.

I. Motor: Directly mounted to pump casing and with lifting and supporting lugs in top of motor enclosure.

2.4 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig (1204-kPa) pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation. Examine foundations and/or inertia bases for suitable conditions where pumps are to be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23 Section “Basic Mechanical Materials and Methods.”

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Concrete bases shall be designed for five times the pump installed weight.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 PUMP INSTALLATION

A. Install pumps according to manufacturer's written installation and alignment instructions. Comply with HI 1.4.

B. Install pumps in locations indicated and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Suspend in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts horizontal. Use continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Mechanical Vibration Isolation." Hanger and support materials are specified in Division 23 Section "Hangers and Supports."

E. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1½ inches (19 to 38 mm) between pump base and foundation for grouting.

2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.4 ALIGNMENT AND GROUTING

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

C. Comply with pump and coupling manufacturers' written instructions. After alignment is correct, tighten foundation bolts evenly but not too firmly.

D. Completely fill baseplate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts. Grout is specified in Division 23 Section "Basic Mechanical Materials and Methods."

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect piping to pumps. Install piping adjacent to machine to allow service and maintenance. Install valves that are same size as piping connected to pumps. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles. Install valves, flexible pipe connectors, gages, and specialty fittings on suction and discharge side of pumps as indicated by details on the Drawings.

C. Install electrical connections for power, controls, and devices. Connect wiring and ground equipment according to Division 26 Sections.

3.6 STARTUP SERVICE

A. Final Checks Before Startup: Engage a factory-authorized service representative to perform startup service and the following preventive maintenance operations and checks before startup:

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check piping connections for tightness.

3. Clean strainers on suction piping.

4. Lubricate bearings.

5. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's recommendations.

6. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.

7. Check that pumps are free to rotate by hand. Pumps for handling hot liquids shall be free to rotate with pump hot and cold. Do not operate pump if it is bound or even drags slightly until cause of trouble is determined and corrected.

8. Check that pump controls are correct for required application.

9. Starting procedure for pumps with shutoff power not exceeding safe motor power.

10. Prime pumps, opening suction valve, closing drains, and preparing pumps for operation.

11. Start motors.

12. Open discharge valves slowly.

13. Check general mechanical operation of pumps and motors.

14. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except that discharge valves are opened sometime before motors are started.

B. Refer to Division 23 Section “Testing, Adjusting and Balancing” for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.7 TRIM IMPELLER

A. Testing, Adjusting and Balancing is the work of Division 23 Section “Testing, Adjusting and Balancing.” After initial testing and balancing, the work of this Section shall include impeller trim. Remove, trim, and reinstall the impeller of all pumps, to match specified performance. Impeller trim shall be performed in a qualified shop acceptable to the pump supplier. Trim impeller to exact diameter as determined under Division 23 Section “Testing, Adjusting and Balancing” matching the desired performance in consultation with the pump curve.

1. Exception: Impeller trim is not required for pumps whose speed is controlled by a variable frequency drive.

2. Exception: Impeller trim is not required for pumps whose motor is 10 HP or smaller.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01.

END OF SECTION 232123

SECTION 232213 - STEAM AND CONDENSATE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel pipe and fittings.
2. Joining materials.

B. Related Requirements:

1. Section 232216 "Steam and Condensate Heating Piping Specialties" for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

1.2 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.1, ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. LP Steam Piping: 15 PSIG
2. Condensate Piping: at 250 deg F.
3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
4. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, plain ends, welded and seamless, Grade B, and Schedule as indicated in piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in piping applications articles; raised ground face, and bolt holes spot faced.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face flanges.
b. Narrow-Face Type: For raised-face flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. Condensate Piping above Grade: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.2 ANCILLARY PIPING APPLICATIONS

A. Vacuum-Breaker Piping: Outlet, same as service where installed.

B. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.3 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

R. Install shutoff valve immediately upstream of each dielectric fitting.

S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 INSTALLATION OF STEAM AND CONDENSATE PIPING SPECIALTIES N

A. Comply with requirements in Section 232216 "Steam and Condensate Heating Piping Specialties" for installation requirements for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for installation of hangers, supports, and anchor devices.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

D. Install hangers for steel steam supply piping and steam condensate piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches of each fitting.

F. Support vertical runs of steel steam supply piping and steel steam condensate piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.8 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.9, "Building Services Piping," and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

D. Prepare test and inspection reports.

END OF SECTION 232213

SECTION 232216 - STEAM AND CONDENSATE HEATING PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following piping specialties for steam and condensate piping:
   1. Stop-check valves.
   2. Safety valves.
   3. Steam traps.
   4. Thermostatic air vents and vacuum breakers.
   5. Strainer

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Strainer.
   2. Valve.
   3. Steam trap.
   4. Air vent and vacuum breaker.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
   1. LP Steam Piping: 15 psig.
   2. Condensate Piping: at 250 deg F.
   3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
   4. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 STRAINERS

A. Y-Pattern Strainers, Cast Iron:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    b. Mueller Steam Specialty; A Watts Water Technologies Company.
    c. Titan Flow Control, Inc.

2. Body: ASTM A126, Class B cast iron, with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
4. Strainer Screen: Stainless steel, 40-mesh strainer or perforated stainless steel basket.
5. Tapped blowoff plug.
6. CWP Rating: 250-psig working steam pressure.

2.3 STOP-CHECK VALVES

A. Stop-Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. A.Y. McDonald Mfg. Co.
    b. Crane Fluid Systems; Crane Co.
    c. Jenkins Valves.

2. Body and Bonnet: Malleable iron.
3. End Connections: Flanged.
4. Disc: Cylindrical with removable liner and machined seat.
5. Stem: Brass alloy.
6. Operator: Outside screw and yoke with cast-iron handwheel.
7. Packing: PTFE-impregnated packing with two-piece packing gland assembly.
8. Pressure Class: 250.

2.4 STEAM SAFETY VALVES

A. Bronze or Brass Steam Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong International, Inc.
    b. Spirax Sarco Limited.
    c. WATTS; A Watts Water Technologies Company.

2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
5. Pressure Class: 250.

6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet, with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.5 STEAM TRAPS

A. Float and Thermostatic Steam Traps, Cast Iron:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong International, Inc.
    b. Spirax Sarco Limited.
    c. Sterling.

2. Body and Bolted Cap: ASTM A126 cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

2.6 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong International, Inc.
    b. Spirax Sarco Limited.
    c. Sterling.

2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless steel cage.
6. Pressure Rating: 125 psig.
7. Maximum Temperature Rating: 350 deg F.

B. Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong International, Inc.
    b. Johnson Corporation (The).

c. Spirax Sarco Limited.

2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
5. O-Ring Seal: Ethylene propylene rubber.
6. Pressure Rating: 125 psig.
7. Maximum Temperature Rating: 350 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.2 INSTALLATION OF PIPING

A. Install piping to permit valve servicing.

B. Install drains, consisting of a tee fitting, NPS 3/4 full-port ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

C. Install valves according to:

1. Section 230523.11 "Globe Valves for HVAC Piping."
2. Section 230523.12 "Ball Valves for HVAC Piping."
3. Section 230523.13 "Butterfly Valves for HVAC Piping."
4. Section 230523.14 "Check Valves for HVAC Piping."
5. Section 230523.15 "Gate Valves for HVAC Piping."

D. Install unions in piping, NPS 2 size and smaller, adjacent to valves, at final connections of equipment and elsewhere as indicated.

E. Install flanges in piping, NPS 2-1/2 Insert pipe size and larger, at final connections of equipment and elsewhere as indicated.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full-port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

3.3 INSTALLATION OF STEAM TRAPS

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.4 INSTALLATION OF SAFETY VALVES

A. Install safety valves according to ASME B31.9, "Building Services Piping."

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Install traps and control valves in accessible locations close to connected equipment.

B. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

END OF SECTION 232216

SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following water treatment for closed-loop hydronic systems: **Contractor shall contract with Walter Louis Fluid Technologies (Existing Water Treatment Specialist) for all water treatment equipment, chemicals, flushing and treatment requirements.**

1. Manual chemical-feed equipment.

B. Related Requirements:

1. Section 232533 "HVAC Makeup-Water Filtration Equipment" for water softeners, RO equipment, and filtration equipment.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to hydronic systems.

1. Include plans, elevations, sections, and attachment details.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Dearborn Type AV

B. J.L. Winger Co,

C. Neptune VTF

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 12 gal.
2. Minimum Working Pressure 200 PSI

2.3 CORROSION TEST COUPON RACK

A. Chilled Water: PVC rack

2.4 Provide (3) sample coupon rack for each system described above.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install water testing equipment on wall near water chemical application equipment.

D. Mount sensors and injectors in piping circuits.

3.2 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.

B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 "Hydronic Piping Specialties."

END OF SECTION 232513

SECTION 233113 – METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 230100 “Basic Mechanical Requirements,” and Section 230500 “Basic Mechanical Materials and Methods” apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes metal ducts and plenums for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg (minus 500 to plus 2500 Pa). Metal ducts include the following:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner (For TV studio only)
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections include the following:

1. Division 07 Sections “Penetration Firestopping” for fire-resistant sealants for use around duct penetrations and fire-damper installations in fire-rated floors, partitions, and walls.
2. Division 08 Section “Access Doors and Frames” for wall- and ceiling-mounted access doors and for access to concealed ducts.
3. Division 08 Section “Louvers and Vents” for intake and relief louvers and vents connected to ducts and installed in exterior walls.
4. Division 23 Section “Mechanical Insulation.”
5. Division 23 Section “Duct Accessories” for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
6. Division 23 Section “Air Terminals” for temperature control terminal units.
7. Division 23 Section “Diffusers, Registers and Grilles.”
8. Division 23 Section “Control Systems” for automatic control dampers and actuators.

9. Division 23 Section “Testing, Adjusting and Balancing” for air balancing and final adjusting of manual volume dampers.

1.3 DEFINITIONS

A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C168.

1.4 PERFORMANCE REQUIREMENTS

A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by the design professional. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

B. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA *HVAC Duct Construction Standards – Metal and Flexible* and performance requirements and design criteria indicated in Part 3 of this Section.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.5 SUBMITTALS

A. Product Data: For each type of the following products:

1. Sealants and gaskets.

2. Manufactured ductwork and duct fittings (if applicable).

3. MSDS (Material Safety Data Sheet) for each adhesive and sealant furnished.

4. Sheet metal thicknesses.

5. Joint and seam construction and sealing.

6. Reinforcement details and spacing.

7. Materials, fabrication, assembly, and spacing of hangers and supports.

B. Coordination Drawings: Comply with Division 23 Section “Basic Mechanical Requirements” for Coordination Drawings. Include reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.

2. Suspended ceiling components and ceiling suspension assembly members.

3. Other systems installed in same space as ducts.

4. Structural members to which duct will be attached.

5. Size and location of initial access modules for acoustical tile.

6. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.

7. Penetrations of smoke barriers and fire-rated construction.

8. Ceiling-mounting items and/or items penetrating finished ceiling, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Field quality-control test reports: Indicate and interpret test results for compliance with performance requirements.

D. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.6 QUALITY ASSURANCE

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

1. AWS D1.1/D1.1M, “Structural Welding Code – Steel,” for hangers and supports.

2. AWS D9.1M/D9.1, “Sheet Metal Welding Code,” for duct joint and seam welding.

B. NFPA Compliance: Comply with NFPA 90A, “Installation of Air Conditioning and Ventilating Systems.”

C. Comply with NFPA 96, “Ventilation Control and Fire Protection of Commercial Cooking Operations” for range hood ducts, unless otherwise indicated.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - “Systems and Equipment” and Section 7 – “Construction and System Start-Up.”

E. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 – “HVAC System Construction and Insulation.”

1.7 REFERENCES

A. ANSI/SMACNA Standard 006-2006 *HVAC Duct Construction Standards – Metal and Flexible*, as published by the Sheet Metal and Air Conditioning Contractors’ National Association. 3rd ed. Chantilly, VA: SMACNA, 2005. All references to this document throughout this Section refer to this specific edition.

B. ANSI/SMACNA Standard 016-2012 *HVAC Air Duct Leakage Test Manual*, as published by the Sheet Metal and Air Conditioning Contractors’ National Association. 2nd ed. Chantilly, VA: SMACNA, 2012. All references to this document throughout this Section refer to this specific edition.

C. ACR 2006: National Air Duct Cleaners Association. *Assessment, Cleaning, & Restoration of HVAC Systems.* 4th ed. Washington, DC: NADCA, 2006. All references to this document throughout this Section refer to this specific edition.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver sealant and firestopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle sealant and firestopping materials according to manufacturer's written recommendations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Fibrous-Glass Duct Liner:

    a. CertainTeed Corporation "ToughGard."
    b. Knauf Fiber Glass GmbH "Duct Liner E-M."
    c. Johns Manville Corporation "Permacote Linacoustic."
    d. Owens-Corning Fiberglas Corporation "Aeroflex Plus."

2. Field-Applied Duct Sealant Materials:

    a. Ductmate, Inc.
    b. Hardcast, Inc.
    c. McGill Air Seal Corporation.
    d. or approved equal.

3. Optional Manufactured Duct Slide-on Flange System:

    a. Ductmate, Inc.
    b. Nexus Inc.
    c. Ward Industries, Inc.

4. Optional Round Duct Coupling System:

    a. Lindab, Inc. "Spirosafe"

2.2 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA *HVAC Duct Construction Standards – Metal and Flexible* for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Sheet Gage: SMACNA standards not withstanding all ductwork penetrations through a 1-hour fire barrier shall have no material thinner than 24-gage.

C. Galvanized Sheet Steel: Comply with ASTM A653 / A653M.

1. Galvanized Coating Designation: G90 (Z275).

2. Finishes for Surfaces Exposed to View: Mill-phosphatized.

D. Reinforcement Shapes and Plates: ASTM A36 / A36M, steel plates, shapes, and bars; black and galvanized. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Comply with Articles 2.5 through 2.9, including all accompanying Tables and Figures, of the SMANCA HVAC Duct Construction Standards.

2.3 SEALANT MATERIALS

A. Two-Part Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal; Hardcast® Two-Part Sealing System, Uni-Cast® by McGill AirSeal Corporation, or equal.

B. One-Part Sealing System: Flexible, adhesive sealant, fiber-reinforced, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts; “Uni-Mastic 181” by McGill AirSeal Corporation or equal.

C. Water-Based Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

D. Formed-on Duct Connectors: Flange shop roll-formed onto edge of ductwork, with corner closures, cleats and gaskets for seal; TDC or TDF constructed per SMACNA T-25a or T-25b.

1. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use O.

2. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

3. Contractor’s Option: Proprietary manufactured slide-on duct connectors by Ductmate, Ward, or Nexus meeting the above requirements will be accepted wherever formed-on duct connectors are required by these specifications.

2.4 RECTANGULAR DUCT FABRICATION

A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA *HVAC Duct Construction Standards – Metal and Flexible*. Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, deflection limits, and joint types and intervals, except where more stringent requirements are specified herein.

B. All sheet metal shall be a minimum of 24-gage thickness in any case. Use 24-gage sheet metal where SMACNA allows thinner material.

C. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

D. Materials: Free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

E. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches (480 mm) and larger and 0.0359-inch (0.9 mm) thick or less, with more than 10 sq. ft. (0.93 sq. m) of unbraced panel area, unless ducts are lined.

F. Pressure Classification: See Schedule in Part 3 of this Section.

G. Seal Classification: See Schedule in Part 3 of this Section.

H. Longitudinal Seams: Pittsburgh lock constructed per Type L-1 of SMACNA Figure 2-2 shall be used on all longitudinal seams. See “Seam and Joint Sealing” in Part 3 of this Section for further requirements.

I. Duct sizes shown on plans are free area sizes and do not include the thickness of internal duct liner, if any. For internally lined ductwork, increase the indicated duct dimensions to account for the liner thickness.

J. Contractor is free to alter the indicated sizes of rectangular duct to suit field conditions, provided that revised size is selected for friction loss no greater than that of indicated size. No prior approval by the Engineer is required for equal-friction duct size changes unless proposed size has an aspect ratio greater than 4 to 1.

K. All square-throat elbows of angle greater than 45° shall include single-thickness turning vanes.

L. Divided flow branches shall be Type 1 or Type 2 per SMACNA Figure 4-5. Type 3 divided flow branches are permitted only where expressly shown. Seek Engineer’s approval of Type 3 where space and/or layout clearances prohibit Type 1 or Type 2.

M. Branch connections shall be per SMACNA Figure 4-6, except that straight taps are not permitted. All rectangular branch duct takeoffs shall use the 45 degree shoe-tap design. Spin-ins, air extractors and scoops are not permitted.

N. Offsets and transitions shall be per SMACNA Figure 4-7, except that offset Type 2 (mitered) is limited to an angle of 45°.

O. Fittings at obstructions shall be per SMACNA Figure 4-8, except that Figure D is not permitted. Use Figure 4-8.B in lieu of Figure 4-8.D. Seek Engineer’s approval of Figure 4-8.D where space and/or layout clearances prohibit use of Figure 4-8.B.

2.5 ROUND DUCT AND FITTING FABRICATION

A. Contractor’s Option: The contractor is permitted to furnish spiral lock-seam round or flat-oval ductwork anywhere rectangular duct is indicated, provided the Contractor’s coordination drawings demonstrate that adequate ceiling clearances and space required by other trades will permit round ductwork. If this option is chosen, round duct sizes shall be selected by the Contractor according to “equal friction” with respect to the rectangular sizes shown.

B. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA *HVAC Duct Construction Standards – Metal and Flexible* except that 26-gage is the thinnest material acceptable. Longitudinal-seam round ducts (“stovepipe”) of a minimum 24-gage thickness, will be permitted on 1/2-inch and 1-inch pressure classifications only.

C. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA *HVAC Duct Construction Standards – Metal and Flexible*, with metal thicknesses specified for longitudinal-seam straight ducts.

D. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance..

E. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1½ times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA HVAC Duct Construction Standards – Metal and Flexible unless otherwise indicated.

2. 90-Degree, 2-Piece, Mitered Elbows: Use only if approved by the Engineer where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.

3. Round Elbows 8 Inches (200 mm) and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

4. Round Elbows 9 through 14 Inches (225 through 355 mm) in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

5. Round Elbows Larger Than 14 Inches (355 mm) in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.

2.6 SHOP- AND FIELD-FABRICATED PLENUMS

A. Description: Provide galvanized steel (unless noted otherwise) air plenums in accordance with Chapter 9 of SMACNA *HVAC Duct Construction Standards – Metal and Flexible*. Air plenums required for this project include:

1. Return air / outdoor air mixing plenums for attachment to the inlet end of air handling units, excluding blower coil units, with connection points for outdoor and return air ducts. Construction shall be 2-inch insulated double wall with solid inner liner; coordinate size, orientation, and layout with Division 23 Section “Modular Packaged Air-Handling Units” and the Drawings.

2. Outdoor air intake plenums for attachment to exterior outdoor air intake louvers, with connection point(s) for outdoor air duct(s). Construction shall be single wall with exterior insulation; coordinate size, orientation, and layout with Division 08 Section “Louvers and Vents” and the Drawings.

3. Exhaust air plenums for attachment to exterior exhaust louvers, with connection point(s) for exhaust air duct(s). Construction shall be single wall uninsulated; coordinate size, orientation, and layout with Division 08 Section “Louvers and Vents” and the Drawings.

4. Other HVAC plenums as indicated on Drawings.

B. Shop fabricate plenums to greatest extent possible with a minimum of joints and to minimize field fabrication and assembly.

C. Fabricate plenums with standing seam construction and angle reinforcement. Fabricate close-off sheets from plenum sides, top, and bottom to damper frames. Bolt close-off sheets to frame flanges and housings.

D. Fabricate plenums with sheet metal walls, top, and bottom panels. Do not use building walls, ceilings or floors as a portion of the plenum boundary, except where expressly shown on Drawings.

E. Reinforce plenums with galvanized or painted steel angles.

F. Seal joints as required in Part 3 of this Section.

G. Fabricate drain pans for air plenums adjacent to exterior louvers with external connection and vented deep-seal trap for drainage piping with a 3/4-inch (20-mm) pipe connection. Fabricate and reinforce drain pans of same material and thickness as housing, 2 inches (50 mm) deep with rolled edges. Solder seams.

H. Fabricate plenums with reinforced openings for access doors at least 20 inches (500 mm) wide by 48 inches (1200 mm) high and located for access to each item of equipment housed. Each plenum shall have at least one access door; more if shown on Drawings. Access doors shall swing out for negative pressure plenums and in for positive pressure plenums. Refer to Division 23 Section “Duct Accessories” for access doors.

I. Mount automatic control dampers in air mixing plenums where applicable. Control dampers are supplied as the work of Division 23 Section “Control Systems.”

2.7 HANGERS AND SUPPORTS

A. General: Support all ductwork in accordance with Chapter 5 of SMACNA *HVAC Duct Construction Standards – Metal and Flexible* except where more stringent requirements are specified herein.

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.

2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

C. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

2. Strap and Rod Sizes: Comply with SMACNA *HVAC Duct Construction Standards – Metal and Flexible* for steel sheet width and thickness and for steel rod diameters.

3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports: Steel shapes complying with ASTM A36.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.

3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.8 SHOP PRIME PAINT

A. All aluminum and galvanized steel ductwork that will be installed exposed to view in finished spaces shall be shop-primed to accept field paint.

B. Primer for galvanized steel ducts shall be galvanized metal primer with total dry film thickness of 1.2 mils; such as Moore #155 or equal. Coordinate brand and selection with the party responsible for performance of Division 09 Painting Sections.

C. Primer for aluminum shall be acrylic- or alkyd-based metal primer specifically recommended by the manufacturer for use over aluminum, with total dry film thickness of 1.4 mils; such as Moore #163 or equal. Coordinate brand and selection with the party responsible for performance of Division 09 Painting Sections.

D. Primer for carbon steel ducts shall be suitable for high temperature applications.

PART 3 - EXECUTION

3.1 DUCT PRESSURE CLASS SCHEDULE

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Constant-volume Supply (Outside air on downstream of energy recovery units is considered “Supply Air” or “Outside Air” as noted on Drawings) Ducts including supply ductwork associated with all energy recovery air handling units: 4-inch wg (1000 Pa).

2. Variable-volume Supply and Outside Air (connected to energy recovery units) Ducts upstream of VAV boxes: 3-inch wg (750 Pa).

3. Variable-volume Supply and Outside Air (connected to energy recovery units) Ducts downstream of VAV boxes: 1-inch wg (250 Pa).

4. Outdoor Air Ducts (outside air for energy recovery units included in this category is only ducts from outside air louver to energy recovery unit intake): 2-inch wg (500 Pa), positive or negative pressure as applicable.

5. Return Ducts: 2-inch wg (500 Pa), positive or negative pressure as applicable.

6. Transfer Ducts: 1/2-inch wg (125 Pa).

7. Exhaust Ducts: 2-inch wg (500 Pa), positive or negative pressure as applicable except at exhaust fans, which shall be 3 inch wg (750 Pa).

8. Supply Ducts off Blower Coil units is all Apartments: 1/2-inch wg (125 Pa).

3.2 DUCT MATERIAL SCHEDULE

A. All ducts shall be galvanized steel

B. Internal lining shall only be permitted for TV studio.

C. Kitchen exhaust duct shall be minimum 18 gauge welded 316 Stainless Steel.

3.3 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA *HVAC Duct Construction Standards – Metal and Flexible* unless otherwise indicated.

B. Install round ducts in lengths not less than 12 feet (3.7 m) unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12-inches (300 mm), with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1-inch (25 mm), plus allowance for insulation thickness.

I. Duct sizes shown on plans are free area sizes. For double wall duct ductwork, increase the indicated duct dimensions to account for the insulation and sheet metal thickness (2 inches (50mm)).

J. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

K. Install duct accessories as required by Division 23 Section “Duct Accessories.”

L. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

M. Drawings are diagrammatic in nature. Not necessarily all fittings and offsets are shown. Provide all required fittings and offsets as required by field conditions and coordination with the work of other trades, whether specifically shown or not, for a complete and functional installation.

N. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

O. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

P. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1½ inches (38 mm).

Q. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section “Duct Accessories.” Firestopping materials and installation methods are specified in Division 07 Section “Penetration Firestopping.”

R. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA’s “Duct Cleanliness for New Construction.” Duct interiors shall be cleaned to meet the Intermediate Level of cleanliness.

S. Rigid (sheet metal) elbows shall be provided at all connections to diffusers.

3.4 SEAM AND JOINT SEALING SCHEDULE

A. General: Ducts noted as welded in the Duct Material Schedule above shall be made liquid-tight with all joints and seams full-penetration welded continuously along the entire length of the seam or joint. Otherwise, seal duct seams and joints according to the duct pressure class indicated and as described in SMACNA *HVAC Duct Construction Standards – Metal and Flexible* except where more stringent requirements are specified herein.

B. Seal externally insulated ducts before insulation installation.

C. Seal Class Schedule: Seal Class A and Leakage Class 4 is required for all ducts except as noted below.

1. Spiral lock-seams need not be sealed.

2. Transfer air ducts and transfer air boots need not be sealed.

D. Rectangular Duct: Sealant materials and methods shall be at contractor’s option, chosen from among the products specified in Part 2 of this Section; provided that the above seal class and leakage class schedule is met.

E. Round Duct: Transverse joints shall be made with a SMACNA RT-1 interior slip coupling beaded at center, fastened to duct with screws; in addition, apply Two-Part Sealing System continuously around exterior side of joint.

1. Contractor’s Option: Furnish prefabricated round duct connection system consisting of self-sealing gasketed fittings with double-lipped, U-profile, EPDM rubber gasket secured with stainless steel band; “Spirosafe” by Lindab, Inc. Manufacture ducts according to connection system manufacturer’s tolerances. Round duct joints made with Lindab “Spirosafe” fittings do not require the additional sealant specified above.

3.5 HANGING AND SUPPORTING

A. Install rigid round, rectangular, and flat-oval metal duct with support systems indicated in SMACNA *HVAC Duct Construction Standards – Metal and Flexible.*

B. Support horizontal ducts within 24-inches (600 mm) of each elbow and within 48-inches (1200 mm) of each branch intersection.

C. Support vertical ducts at maximum intervals of 16 feet (5 m) and at each floor.

D. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

E. Install concrete inserts before placing concrete.

F. Install powder-actuated concrete fasteners after concrete is placed and completely cured. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4-inches (100 mm) thick.

G. Repair any building insulation or building fireproofing materials, whether new or existing, that are removed or scraped away in order to attach hangers and supports, so as to maintain an equivalent insulation or fire rating as existed without said hanger or support attachment.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section “Duct Accessories.”

B. Comply with SMACNA *HVAC Duct Construction Standards – Metal and Flexible* for branch, outlet and inlet, and terminal unit connections.

3.7 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA *HVAC Duct Construction Standards – Metal and Flexible* and prepare test reports:

1. 25% of all outdoor ducts.

2. 25% of all indoor ducts if design pressure rating is greater than 3-inch w.g.

B. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

C. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days’ advance notice for testing.

D. Maximum Allowable Leakage: Comply with requirements for Leakage Class 4.

E. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.8 CLEANING NEW SYSTEMS

A. Create other openings to comply with duct standards.

B. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.

4. Coils and related components.

C. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Clean coils and coil drain pans according to ACR 2006. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

3. Contractor shall maintain all systems to be kept clean until building Substantial Completion of Project has been obtained.

D. Cleanliness Verification:

1. Visually inspect metal ducts for contaminants.

2. Where contaminants are discovered, clean ducts.

E. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

END OF SECTION 233113

SECTION 233300 – DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 230100 “Basic Mechanical Requirements,” and Section 230500 “Basic Mechanical Materials and Methods” apply to the work of this Section as if fully repeated herein.

C. Section 23 0900, “Control Systems” for automatic control dampers under the control of the Building Direct Digital Control system.

1.2 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Manual volume dampers.
3. Fire dampers, smoke dampers, and fire/smoke dampers.
4. Duct silencers.
5. Turning vanes.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.
10. Remote Damper Regulator.
11. Air Flow Regulator

B. Related Sections:

1. Division 23 Section “Control Systems” for actuators associated with automatic control dampers.
2. Division 26 Section “Fire Alarm Systems” for duct-mounted fire detectors.

1.3 SUBMITTALS

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

B. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

C. Room-by-Room Listing: For constant airflow regulators as specified herein, submit room-by-room listing for entire project that indicates model number of constant airflow regulator proposed, airflow in CFM and associated room number.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, “Installation of Air Conditioning and Ventilating Systems.”

B. Comply with AMCA 500-D testing for damper rating.

1.5 REFERENCED STANDARDS

A. Sheet Metal and Air Conditioning Contractors’ National Association. *HVAC Duct Construction Standards – Metal and Flexible.* 3rd ed. Chantilly, VA: SMACNA, 2005.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed, but not less than two (2).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. HVAC Dampers (all types):

a. Greenheck Inc.

b. Nailor Industries Inc.

c. Ruskin Company.

2. Duct Silencers:

a. Greenheck

b. Industrial Acoustics Co.

c. Rink Sound Control; Div. of Ruskin Mfg. Co.

d. Ruskin

e. United Sheet Metal; Div. of United McGill Corp.

f. Vibro-Acoustics.

3. Turning Vanes:

a. Ductmate Industries, Inc.

b. Duro Dyne Inc.

c. Metalaire, Inc.

d. Semco Incorporated.

4. Duct-Mounted Access Doors:

a. American Warming and Ventilating; a division of Mestek, Inc.

b. Cesco Products; a division of Mestek, Inc.

c. Ductmate Industries, Inc.

d. Flexmaster U.S.A., Inc.

e. Greenheck Fan Corporation.

f. McGill AirFlow LLC.

g. Nailor Industries Inc.

h. Ventfabrics, Inc.

i. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

j. Ruskin Company.

5. Flexible Connectors:

a. Ductmate Industries, Inc.

b. Duro Dyne Inc.

c. Ventfabrics, Inc.

6. Flexible Ducts:

a. Type 8B by Flexmaster USA, Inc.

b. “M-KE” by ThermaFlex.

7. Air Flow Regulator

a. American ALDES Ventilation Corporation, Bradenton, Florida.

b. United Enertech

2.2 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A653/A653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2D finish for concealed ducts and No. 4 finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B221 (ASTM B221M), Alloy 6063, Temper T6.

F. Minimum Thickness: All sheet steel used on this project shall be a minimum of 24-gage thickness, and all aluminum sheets shall be a minimum of 0.04-inch thickness, regardless of whether or not SMACNA standards permit thinner gage material.

G. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

H. Tie Rods: Comply with Articles 2.5 through 2.9, including all accompanying Tables and Figures, of the SMANCA HVAC Duct Construction Standards.

2.3 MANUAL VOLUME DAMPERS

A. Manual volume dampers shall be standard leakage rating, with linkage outside airstream, suitable for horizontal or vertical applications. Volume dampers may be factory-manufactured or contractor-fabricated per SMACNA Fig. 7-4/7-5.

B. Material: Match material options throughout this subsection to the material of adjacent ductwork. For duct material, refer to Division 23 Section "Metal Ducts."

C. Frames: Hat-shaped channels with mitered and welded corners, flanges for attaching to walls, and flangeless frames for installing in ducts.

1. Galvanized-steel, 16-gage or 0.064-inch (1.62-mm) minimum thickness, for use in galvanized steel ducts.

2. Aluminum sheet, 12-gage or 0.100-inch- (2.5-mm-) minimum thickness, for use in aluminum ducts.

3. Stainless-steel, 16-gage or 0.064-inch (1.62-mm) minimum thickness, for use in stainless steel ducts.

D. Blades: Multiple-blade; single-blade if duct dimension is 12-inch or less in the direction perpendicular to damper axis. Parallel or opposed-blade design (contractor's choice, unless a specific type is indicated). Stiffen damper blades for stability.

1. Galvanized-steel, 16-gage or 0.064-inch (1.62 mm) thick, for use in galvanized steel ducts.

2. Roll-Formed Aluminum, 12-gage or 0.10-inch- (2.5-mm-) thick aluminum sheet, for use in aluminum ducts.

3. Stainless-steel, 16-gage or 0.064-inch (1.62 mm) thick, for use in stainless steel ducts.

E. Blade Axles: Galvanized steel, aluminum, or stainless steel, as required to match blade material. Dampers shall have axles full length of damper blades, and bearings at both ends of operating shaft.

F. Bearings: Oil-impregnated bronze, molded synthetic, and stainless-steel sleeve-type are acceptable.

G. Tie Bars and Brackets: Galvanized steel or aluminum.

H. Jackshaft:

1. Size: 1-inch (25-mm) diameter.

2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

I. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.

2. Include center hole to suit damper operating-rod size.

3. Include elevated platform for insulated duct mounting.

4. For all insulated ductwork, provide extended shaft parts and kit to extend handle through insulation. Provide Ruskin crank arms, extended shaft and hand quadrant (ESK050, ESK050B or approved equal). Damper shaft and handle shall be completely insulated. Refer to Division 23 “Mechanical Insulation.”

2.4 AUTOMATIC CONTROL DAMPERS

A. Refer to Section 230900, “Control Systems” for automatic control damper requirements.

2.5 FIRE DAMPERS

A. Type: Dynamic; rated and labeled according to UL 555 (2002 Edition). Label according to UL 555C if used in a rated ceiling application.

B. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and 2000-fpm (10-m/s) velocity.

C. Fire Rating: 1½ hours.

D. Frame: SMACNA Type A, B or C as indicated; fabricated with roll-formed, 20-gage galvanized steel; with mitered and interlocking corners. If no indication is given, use Frame Type B for rectangular ducts and Frame Type C for round ducts.

E. Mounting Orientation: Vertical or horizontal as indicated.

F. Blades: Roll-formed, interlocking, galvanized sheet steel.

G. Horizontal Dampers: Include blade lock and stainless-steel negator closure spring.

H. Single-use Fusible Link: Replaceable, 165ºF (74 C) rated, fusible links.

I. Mounting Sleeve: Factory-supplied, factory or field-installed, galvanized sheet steel sleeve; length as indicated. Include factory-supplied, field-installed two-piece “picture-frame” mounting angles with pre-punched fastener holes.

    1. Factory Insulation: If used on a duct which requires thermal insulation per Division 23 Section “Mechanical Insulation,” then provide fire damper sleeve with factory thermal insulation. Damper/sleeve assembly with thermal insulation shall be listed and labeled according to UL555.

    2. Direct Grille Mounts: Where specifically indicated, furnish integral factory sleeve/mounting angle assembly UL-listed for direct grille attachment.

    3. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

J. Multiple-Section Assembly: Where indicated fire damper size exceeds the maximum UL-approved dimensions of the manufacturer’s UL-listed product line, provide multiple-section dampers including mullions and other hardware necessary for a UL-approved multi-section fire damper assembly.

2.6 TURNING VANES

A. Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

B. Contractor-Fabricated to comply with SMACNA’s “HVAC Duct Construction Standards – Metal and Flexible,” Figures 4-3 and 4-4 single thickness type, or Contractor may elect to provide manufactured turning vanes as described below.

    1. Manufactured Turning Vanes: Fabricate of 1½-inch- (38-mm-) wide, curved blades set 3/4-inch (19 mm) o.c.; support with bars perpendicular to blades set 2-inches (50 mm) o.c.; and set into side strips suitable for mounting in ducts.

    2. Double-thickness turning vanes will also be acceptable.

2.7 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Factory-manufactured doors, airtight and suitable for duct pressure class.

B. Door: Double wall, rectangular, galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.

C. Insulation: 1-inch (25-mm-) thick, fibrous-glass or polystyrene-foam board.

D. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.

E. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

F. Number of Hinges and Locks: Two hinges, or continuous piano hinge, and two sash locks.

2.8 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5¾-inches (146 mm) wide attached to 2 strips of 2¾-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene or polychloroprene.

1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).

2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.

3. Service Temperature: Minus 40 to plus 200ºF (Minus 40 to plus 93 C).

E. Thrust Limits: As specified in Division 23 Section “Mechanical Vibration Isolation.”

2.9 FLEXIBLE DUCTS

A. General: Comply with UL 181, Class 1. Factory-fabricated, insulated, round duct, with an outer jacket enclosing glass-fiber insulation around a continuous inner liner.

1. Reinforcement: Galvanized steel wire helix encapsulated in inner liner.

2. Outer Jacket: Polyethylene vapor-barrier film.

3. Inner Liner: CPE film, acoustically transparent to mid-range sound energy.

B. Required Pressure Ratings:

1. Sizes 12-inch and smaller: At least 8-inch wg positive.

2. Sizes larger than 12-inch: At least 4-inch wg positive.

3. Burst Rating: 2.5 times working pressure rating above.

C. Velocity Rating: 4000 fpm.

D. Temperature Rating: -20°F to +250°F.

E. Thermal Rating: Minimum R-4.2 thermal resistance.

F. Flexible Duct Connector Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18-inches, to suit duct size.

G. Flexible duct length shall not exceed 6 foot.

H. Provide flexible ducts with Flexflow elbow by Thermaflex for connections to air devices.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts.

1. Locate dampers at least two duct diameters from fittings and as far away as possible from outlets.

2. Install steel volume dampers in steel ducts.

3. Install aluminum volume dampers in aluminum ducts.

4. Install stainless steel volume dampers in stainless steel ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers, smoke dampers, and fire/smoke dampers according to UL listing.

H. Install duct silencers rigidly to ducts.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links.

2. Downstream of in-duct coils.

3. Adjacent to duct mounted air flow regulator to allow for inspection and removal.

4. Elsewhere as indicated.

5. Upstream of all airflow measuring stations.

J. Install access doors with swing against duct static pressure.

K. Access Door Size: 18 by 10-inches (460 by 250 mm) unless noted otherwise

L. Label access doors according to Division 23 Section “Basic Mechanical Materials and Methods” to indicate the purpose of access door.

M. Label fire dampers, combination fire and smoke dampers and smoke dampers according to Division 23 Section “Basic Mechanical Materials and Methods” to indicate the location of each damper.

N. Install flexible connectors to connect ducts to equipment.

O. For fans developing static pressures of 5-inch wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

P. Connect air devices to ducts with flexible duct clamped or strapped in place.

Q. Install flexible ducts in accordance with the following:

1. Turn radius of flexible duct at duct centerline shall not exceed one times nominal duct diameter.

2. At least one support shall be installed for every run of flexible duct that is 60-inches (1500 mm) long or longer; more if needed to comply with next paragraph.

3. Support flexible duct so that it does not contact nor rest upon light fixtures, sprinkler and other piping, ceilings and ceiling hanger wires, electrical conduits and cable tray, and similar items.

4. All supporting material surfaces in direct contact with supported flexible duct shall maintain a minimum of one-inch in contact width along full length of contact.

5. Comply with Figures 3-10 and 3-11 in SMACNA’s *HVAC Duct Construction Standards – Metal and Flexible.* 3rd ed. except where more stringent details are given on the Drawings.

6. Comply with Specifications 3.5, 3.6, and 3.7, paragraphs S3.19 through S3.40, of SMACNA’s *HVAC Duct Construction Standards – Metal and Flexible.* 3rd ed., except where more stringent requirements are specified herein.

7. Flexible ductwork shall not be used on ducted return or exhaust systems.

R. Install duct test holes where required for testing and balancing purposes.

S. Connect air devices to ducts directly or with a minimum 36-inch (900-mm) and a maximum 72-inch (1800-mm) length of flexible duct clamped or strapped in place.

T. Install air flow regulator in rigid ducts, duct collar or register boxes without the use of screws or any other mechanical device. The perimeter gasket provides a seal to grip the interior of the duct in which the unit is installed. Unit may be installed in vertical or horizontal ducting. When

installed in horizontal ducting the unit must be installed with base downward. Install units in accordance with all applicable building and mechanical codes. If installed in a metal duct or duct collar with flexible duct connector the regulator must be inserted at least 0.7 times the duct diameter from the flexible duct and/or duct connector.

U. Install a manual balancing damper upstream of all air terminal units (FTU and VAV) at the branch take-off for pressure reduction.

V. Install a manual balancing damper upstream of all diffusers, grilles and registers, even if just one diffuser, for possible future balancing needs or control stability. Autoflow regulators shall be installed in place of manual balancing damper in all outside supply air and exhaust air served by energy recovery units.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Operate fire dampers to verify full range of movement and verify that proper heat-response device is installed.

4. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

SECTION 233423 – FANS AND VENTILATORS

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. Utility Fans.
2. Roof Exhauster.
3. Axial Fan
4. In-line Centrifugal

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale and coordinated with all building trades.

B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

C. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. All fans shall be licensed to bear the AMCA Performance Air and Sound Certified Ratings Seal. Fan air performance ratings shall be based on test conducted in an AMCA registered laboratory in accordance with AMCA 210 Air Performance Testing and AMCA 300 Sound Performance Testing. Fan curve families (tables will not be accepted) and octave band sound data shall be furnished with submittal data.

B. All fans shall have premium efficiency open dripproof motor unless indicated otherwise. Fans with variable speed drives shall have inverter duty motors. All fans with V-belt drives shall be equipped with adjustable pitch sheave rated for 1.5 times the motor horsepower, shall have sliderail base, and shall have a belt-guard.

C. All fan shafts shall be designed so that the first critical speed is at least 20% over the maximum operating speed. Bearings shall be self-aligning, grease lubricated, anti-friction, pillow block bearings with a minimum life (L50) of 200,000 hours.

D. Where fans are other than scheduled the following criteria shall apply: Fans shall be picked at the scheduled flow and static pressure, fan efficiency shall not be more than 5% less efficiency than scheduled fan, fan motor shall not be larger than scheduled motor (manufacturer shall notify Contractor of any larger motor sizes, Contractor can pursue equipment substitution as required in subsection 20 00 52), the fan rpm shall not be within 15% of the maximum or minimum allowable rpm, and in general the fan selections shall be based upon maximum energy efficiency but in no case shall the fan wheel be smaller than what is scheduled. Where selection point is within 15% of the maximum allowable rpm of the fan class, provide a higher fan class.

E. Where Roof curbs for exhaust fans are required, roof curbs shall be constructed of galvanized steel. Curbs are to be internally insulated and fully gasketed between the curb top and fan base with the curb providing full perimeter support and air seal for the unit. The finished height of the roof curb shall be 10” – 12” above the finished roof unless a greater height is required as scheduled or noted on the drawings. The Contractors shall coordinate the curbs with the roof insulation thickness.

2.2 UTILITY FANS (EF-1, EF-3, EF-4)

A. Manufacturers:
   1. Greenheck
   2. Cook
   3. Penn-Barry

B. Housing: Steel, Welded Class II Construction.

C. Fan Wheel: Backward inclined centrifugal wheel, polished shaft.

D. Fans shall have inlet collar, captive spring type isolation. Weather hood, extended lube lines, , drain connection. Permatector resin coating.

E. Grease Trap (EF-1) only.

2.3 Roof Exhauster

A. Manufactures
   1. Greenheck
   2. Cook
   3. Penn-Barry

B. Furnish and install where indicated on the drawings centrifugal roof exhaust fans of the sizes and capacities as scheduled. Centrifugal impeller is to be of heavy aluminum construction with backward inclined or curved hollow airfoil blades. Hoods shall be constructed of aluminum with rolled bead for additional strength and shall be easily removable for servicing. Overall height from the curb shall not exceed that of the models scheduled. Motor and drive assembly shall be vibration isolated from the base and housing. All units shall have U.L. wired safety disconnect switch, sound attenuating roof curb and backdraft damper, in addition to any other accessories listed in the schedule.

C. B. Contractor shall install a vinyl coated steel cable from the motor cover to the base to allow the motor cover to be removed for service but will not permit the cover to be blown away. Cable shall have eyelet or swagged ends with aluminum or galvanized fasteners.

D. Motor shall be ECM with fan mounted fan speed controller for balancing.

2.4 Axial Fan

A. Manufacturers:
   1. Greenheck
   2. Cook
   3. Pen-Barry

B. Tubular painted steel housing

C. Cast Aluminum Propeller

D. Direct Drive – Motor in the Airstream

2.5 IN-LINE CENTRIFUGAL FAN

A. Manufacturers:
   1. Greenheck
   2. Cook
   3. Penn-Barry

B. Furnish and install in-line centrifugal fan of the sizes and capacities as scheduled on the drawings. Centrifugal fan wheel shall be statically and dynamically balanced aluminum backward inclined blades with deep drawn inlet. Fan housing shall be steel construction with hinged access door. Fan construction shall allow complete servicing without removing the fan from the ductwork. Fans shall be belt driven motor out of the air stream. Fans shall be supported from spring isolators with a flexible duct connection located at each connection to the fan. Each fan shall have a wired safety disconnect switch.

C. Fans to be mounted in vertical duct with a horizontal side discharge.

2.6 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.

B. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.ASHRAE/IES 90.1 requires minimum Fan Energy Index (FEI) values for certain types of fans/systems. Retain first paragraph below if ASHRAE/IES 90.1 applies to Project and if manufacturers offer AMCA-certified products. Schedule required minimum FEI values applicable to specific equipment on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install Fans level and plumb.

B. Install units with clearances for service and maintenance.

C. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

3.3 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.5 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

END OF SECTION 233423

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 Special Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 230100 “Basic Mechanical Requirements,” and Section 230500 “Basic Mechanical Materials and Methods” apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes the following:

1. Variable Volume Unit

B. Related sections include Division 23 Section “Control Systems” for control devices and installation associated with air terminals.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities; furnished specialties and accessories; shipping, installed, and operating weights; and sound-power ratings for each model indicated. Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.

B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Wiring Diagrams: Detail wiring for power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

D. Coordination Drawings: Refer to Division 23 Section “Basic Mechanical Requirements.”

E. Operation and Maintenance Data

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 23 Section “Basic Mechanical Requirements.”

B. NFPA Compliance: Install air terminal units according to NFPA 90A, “Standard for the Installation

of Air Conditioning and Ventilating Systems."

C. AHRI Certification: Only air terminals that are certified under the AHRI Standard 880 Certification Program and carry the AHRI Seal will be accepted.

D. ASHRAE Compliance: Meet applicable requirements in ASHRAE 62.1-2019, Section 5 – "Systems and Equipment" and Section 7 – "Construction and System Start-Up."

1.5 COORDINATION

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide Air Terminal Units by one of the following:

1. Price Industries; E.H. Price Co.
2. Titus.
3. Tuttle & Bailey, div. of Hart & Cooley, Inc.

2.2 AIR TERMINAL UNITS, GENERAL

A. Configuration: Pressure independent terminal unit as scheduled; including volume-damper assembly inside unit casing with control components located inside a protective metal shroud. Unit sizes, capacities, maximum and minimum airflows, maximum noise ratings, and maximum air pressure drops shall be as scheduled on the Drawings.

B. Casing: Unis casing shall be welded, galvanized steel. Leak rate shall be no more than 1% of rated capacity at 4" wg. Interior surface of unit casing shall be acoustically and thermally lined with ½", minimum 1.5lb/cu ft. Density glass fiber with foil face. Insulation shall be UL listed and meet NFPA-90A and UL181

C. Factory mounted removable panel on bottom of unit providing access to air valve and entering airside of coil.

D. Straight flange or slip and drive rectangular discharge duct connection.

E. Minimum 22-gage steel or 0.032-inch (0.8-mm) aluminum.

F. Units scheduled with reheat coils shall provide minimum number of rows as indicated on the schedule with maximum of 12 fins per inch. Full fin collars for accurate fin spacing and maximum tube fin contact, 5/8" O.D. seamless copper tubes mechanically espanded into the fin collars leak tested at 300 PSIG.

G. Air valve shall be a 90° rotational damper flow control device with factory installed direct digital

controls (DDC). All controls shall be furnished by controls contractor and mounted and wired in the factory by unit manufacturer. Manufacturer shall provide multiple point averaging flow sensing ring with high and low pressure pneumatic tubes compatible with DDC velocity pressure sensor. A calibration chart shall be provided on each unit.

H. At the contractor's option temperature controls contractor may field mount controls at no additional cost to the owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units level and plumb, according to manufacturer's written instructions, rough-in drawings, original design, and referenced standards. Maintain sufficient clearance for normal service and maintenance.

B. Protect all openings of air terminal units with filters or temporary covers throughout project storage, handling, and placement, to keep clean the interiors of air terminal units.

C. Terminal units shall be continuously insulated with thermal insulation and vapor barrier, in unbroken path from inlet duct through to outlet duct, so that no bare metal surfaces are left uninsulated. Field-insulate any portions of terminal unit if not factory-insulated, including but not limited to heating coil casing and duct inlet collar. Field insulation and vapor barrier are specified in Division 23 Section "Mechanical Insulation."

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches (100 mm) thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

A. Ductwork: Connect ductwork to air terminals according to Division 23 ductwork Sections and

Details on Drawings.

B. Hot Water Piping: Connect heating coils Install piping adjacent to air terminal units to allow service and maintenance. Piping installation requirements are specified Division 23 Section “Hydronic Piping.” Drawings indicate general arrangement of piping, fittings, and specialties.

C. Controls: Field-installed controls specified herein shall be installed and connected as the work of Division 23 Section “Controls.”

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section “Basic Mechanical Materials and Methods” for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

A. Complete installation and startup checks according to manufacturer’s written instructions, and perform the following field tests and inspections:

1. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.

2. Verify that controls and control enclosure are accessible.

3. Verify that control connections are complete.

4. Verify that nameplate and identification tag are visible.

5. Verify that controls respond to inputs as specified.

6. After installing air terminal units, and after electrical circuitry (where applicable) has been energized, test for compliance with requirements.

7. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.

8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

9. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.6 CLEANING

A. After completing system installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION 233600

SECTION 233713 – DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 230100 “Basic Mechanical Requirements,” and Section 230500 “Basic Mechanical Materials and Methods” apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Sections include the following:

1. Division 08 Section “Louvers and Vents” for fixed and adjustable louvers and wall vents installed in exterior walls, whether or not they are connected to ducts.

2. Division 23 Section “Duct Accessories” for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

3. Division 23 Section “Testing, Adjusting, and Balancing” for balancing diffusers, registers and grilles.

1.3 DEFINITIONS

A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.

B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

C. Register: A combination grille and damper assembly over an air opening.

1.4 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples for Initial Selection: Submit manufacturer's color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes; where required or

indicated by note on Schedule. All diffuser, register and grille color finishes shall be selected by the Architect during shop drawing review process only.

C. Room-by-Room Listing: For constant airflow regulators as specified herein, submit room-by-room listing for entire project that indicates model number of constant airflow regulator proposed, airflow in CFM and associated room number.

1.5 QUALITY ASSURANCE

A. Testing: Test and publish performance according to ANSI/ASHRAE Standard 70-2006, “Method of Testing the Performance of Air Outlets and Air Inlets.”

B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, “Standard for the Installation of Air-Conditioning and Ventilating Systems.” Where located less than 84 inches above finish floor, diffusers, registers and grilles shall be designed to prohibit passage of a 1/2-inch sphere.

C. Single-Source: Unless noted otherwise, a single manufacturer shall furnish all diffusers, registers, and grilles.

PART 2 - PRODUCTS

2.1 COMMON REQUIREMENTS, ALL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Diffusers, Registers and Grilles:

    a. Price Industries.
    b. Titus; Air System Components LP.
    c. Tuttle & Bailey.

B. Diffusers, registers, and grilles are scheduled on Drawings. All model numbers, finish designations, border types, and accessory designations are based one manufacturer identified therein. Products by other manufacturers listed above may be furnished, but must be equal in all respects to the device identified, including but not limited to NC, pressure, and cfm ratings.

C. Diffusers, Registers, and Grilles Finish: Acrylic baked enamel paint, pencil hardness HB to H, color as scheduled. The finish shall pass a 250-hour ASTM 870 Water Immersion Test, a 100-hour ASTM D117 Corrosive Environments Salt Spray Test, and a 50 inch-pound ASTM D-2794 Reverse Impact Cracking Test.

D. Integral Balancing Damper: Where dampers are scheduled as an integral part of diffusers and grilles (registers), provide multi-blade gang-operated opposed-blade type, radial-style if used with round ducts; 24 gage galvanized steel, except that aluminum dampers shall be used with aluminum diffusers and registers. Integral dampers shall be operable from the room side of the diffuser or register without special tools.

E. Diffusers, Registers, and Grilles Mounting: Provide border frame mounting type as scheduled. If not scheduled, provide border frame mounting type compatible with ceiling or wall type indicated on Architectural Drawings. Distinguish between flush flat-tee lay-in ceilings, drop-face lay-in

ceilings, and the narrow-tee or screw-slot lay-in ceilings by providing a border type specifically designed for each as applicable; a generic standard lay-in border frame will not be acceptable for multiple lay-in ceiling types.

2.2 PRODUCT SPECIFICATIONS

A. Slot Diffuser: Plenum slot diffuser with width and quantity of slots as scheduled. Unit shall be 24 gauge steel, white finish. 24-gage galvanized steel plenum constructed of double metal thickness with ¼" thick 2-pound insulation.

1. Required Accessories: pattern controller.

2. Refer to scheduling for ceiling installation application.

B. Square Louvered Face:

1. Diffusers shall consist of an outer frame assembly of the sizes and mounting types shown on the plans and outlet schedule. A square or rectangular inlet shall be an integral part of the frame assembly and a transition piece shall be available to facilitate attachment of round duct. An inner core assembly consisting of fixed deflection louvers shall be available in one-, two-, three- or four-way horizontal discharge patterns. The inner core assembly must be removable in the field without tools for easy installation, cleaning or damper adjustment.

2. The finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H.

3. Aluminum construction in locations as noted in Air Device Schedule on plans.

C. Sidewall Grilles - Removable Core

1. Sidewall supply air grilles (SAG) shall be adjustable double deflection type with removable core with a separate mounting frame with a gasketed one-inch wide flange as scheduled. Sidewall return or exhaust grilles shall be single deflection to match sidewall supply grilles in appearance. Where registers are required (SAR or RAR), include a key operated opposed blade volume control.

D. Standard-Performance Grille: Adjustable double-deflection supply grilles, single fixed deflection return grilles, of sizes and performance as scheduled. Blades shall be heavy-duty solid aluminum construction; supply grille blades shall be individually adjustable and held in place without rattling or slip by tension wire or metal friction pivots. Frame shall be roll-formed heavy-duty solid aluminum construction or with 1-inch minimum flange and full penetration welds at the corners. Exposed screw holes shall be countersunk for flush finish surface.

1. Include only as called out on schedule: Integral volume control damper shall be of the opposed blade type and shall be aluminum construction. The damper shall be operable from the register face. The damper shall be finish aluminum.

2. The grille shall be finished in aluminum powered coat. Color will be selected by the Architect during shop drawing submittal review.

E. Other grilles, registers and diffusers not specified above may be specified on the Drawings or by virtue of make and model number on the Schedule.

2.3 FIELD-PROVIDED ACCESSORIES

A. Sight/Sound Screen: Provide 3' flex duct return air screen for all unducted return air grilles.

B. Other accessories may be required by virtue of notations on the Schedule or as detailed on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Install diffusers, registers, and grilles level and plumb.

C. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

E. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

F. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 233713

SECTION 233813 - COMMERCIAL-KITCHEN HOODS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Commercial-kitchen hoods, Type I.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Filters/baffles.
2. Fire-suppression systems.
3. Luminaires.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.
2. Show cooking equipment plan and elevation to confirm minimum code-required overhang.
3. Indicate performance, exhaust and makeup air airflow, and pressure loss at actual Project-site elevation.
4. Show control cabinets.
5. Show fire-protection cylinders, piping, actuation devices, and manual control devices.
6. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
7. Design Calculations: Calculate requirements for selecting seismic restraints.
8. Include diagrams for power, signal, and control wiring.
9. Duct Connections: Detail connections between ducts and hoods, including access doors and panels.
10. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.

1.3 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D 1.1M, "Structural Welding Code - Steel," for hangers and supports; and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for joint and seam welding.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 HOOD MATERIALS

A. Stainless-Steel Sheet: ASTM A666, Type 400 series.

1. Minimum Thickness: 18 GA.
2. Finish: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.

    a. Finish shall be free from tool and die marks and stretch lines and shall have uniform, directionally textured, polished finish indicated, free of cross scratches. Grain shall run with long dimension of each piece.

3. Concealed Stainless-Steel Surfaces: ASTM A480/A480M, No. 2B finish (bright, cold-rolled, unpolished finish).
4. Exposed Surfaces: ASTM A480/A480M, No. 2B finish (bright, cold-rolled, unpolished).
5. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Zinc-Coated Steel Shapes: ASTM A36/A36M, zinc coated according to ASTM A123/A123M requirements.

C. Sealant: ASTM C920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial-kitchen hood application. Sealants, when cured and washed, shall comply with requirements in 21 CFR 177.2600, for use in areas that come in contact with food.

1. Color: As selected by Architect from manufacturer's full range.
2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.

D. Sound Dampening: NSF-certified, non-absorbent, hard-drying, sound-deadening compound for permanent adhesion to metal in minimum 1/8-inch thickness that does not chip, flake, or blister.

E. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and that passes testing according to UL 710.

2.3 EXHAUST HOOD FABRICATION, TYPE I HOOD

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CaptiveAire Systems.
2. Grease Master.
3. Greenheck Fan Corporation.

B. Weld all joints exposed to grease with continuous welds, and make filters/baffles or grease extractors and makeup air diffusers easily accessible for cleaning.

1. Fabricate hoods according to NSF 2, "Food Equipment."
2. Hoods shall be listed and labeled, according to UL 710, by a testing agency acceptable to authorities having jurisdiction.
3. Include access panels as required for access to fire dampers and fusible links.
4. Duct Collars: Minimum 0.0598-inch-thick steel at least 3 inches long, continuously welded to top of hood and at corners. Fabricate a collar with a 0.5-inch-wide duct flange.

C. Hood Configuration: Exhaust only.

D. Hood Style: Wall-mounted canopy.

E. Filters/Baffles: Removable, stainless-steel. Fabricate stainless steel for filter frame and removable collection cup and pitched trough. Exposed surfaces shall be pitched to drain to collection cup. Filters/baffles shall be tested according to UL 1046, "Safety for Grease Filters for Exhaust Ducts," by an NRTL acceptable to authorities having jurisdiction.

F. Luminaires: Surface-mounted, incandescent fixtures and lamps with lenses sealed vapor tight. Wiring shall be in conduit on hood exterior. Number and location of luminaires shall provide a minimum of 70 fc at 30 inches above finished floor.

1. Light switches shall be mounted on front panel of hood canopy.
2. Luminaires: Incandescent complying with UL 1598.

G. Comply with hood control requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC".

H. Hood Controls: Hood-mounting control cabinet, fabricated of stainless steel.

1. Exhaust Fan: 120 minute timer switch shall start and stop the exhaust fan. Interlock exhaust fan with makeup air supply fan to operate simultaneously. Interlock exhaust fan with fire-suppression system to operate fan(s) during fire-suppression-agent release and to remain in operation until manually stopped. Include red pilot light to indicate fan operation.

2.4 FIRE-SUPPRESSION SYSTEM, WET CHEMICAL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ansul; brand of Johnson Controls International plc, Building Solutions North America.
2. Badger Fire Protection; a Carrier company.
3. Pyro-Chem; brand of Johnson Controls International plc, Building Solutions North America.

B. Description: Engineered distribution piping designed for automatic detection and release or manual release of fire-suppression agent by hood operator. Fire-suppression system shall be listed and labeled for complying with NFPA 17A, "Wet Chemical Extinguishing Systems," by a qualified testing agency acceptable to authorities having jurisdiction.

1. Steel Pipe, NPS 2 and Smaller: ASTM A53/A53M, Type S, Grade A, Schedule 40, plain ends.

2. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
3. Piping, fusible links and release mechanism, tank containing the suppression agent, and controls shall be factory installed. Controls shall be in stainless-steel control cabinet mounted on wall. Furnish manual pull station for wall mounting. Exposed piping shall be covered with chrome-plated aluminum tubing. Exposed fittings shall be chrome plated.
4. Liquid Extinguishing Agent: Noncorrosive, low-pH liquid.
5. Fire-suppression system controls shall be integrated with controls for fans, lights, and fuel supply and located in a single cabinet for each group of hoods immediately adjacent.
6. Wiring shall have color-coded, numbered terminal blocks and grounding bar. Spare terminals for fire alarm, optional wiring to start fan with fire alarm, red pilot light to indicate fan operation, and control switches shall all be factory wired in control cabinet with relays or starters. Include spare terminals for fire alarm, and wiring to start fan with fire alarm.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Coordinate equipment layout and installation with adjacent Work, including luminaires, HVAC equipment, plumbing, and fire-suppression system components.

B. Complete field assembly of hoods where required.

1. Make closed butt and contact joints that do not require filler.
2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in "General Hood Fabrication Requirements" Article.

C. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.

D. Make cutouts in hoods where required to run service lines and to make final connections, and seal openings according to UL 1978.

E. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners unless otherwise indicated.

F. Install hoods to operate free from vibration.

G. Install seismic restraints according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines," Appendix A, "Seismic Restraint Details."

H. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches o.c. maximum.

I. Install sealant in joints between equipment and abutting surfaces with continuous joint backing unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

J. Install lamps, with maximum recommended wattage, in equipment with integral lighting.

K. Set initial temperatures, and calibrate sensors.

L. Set field-adjustable switches.

M. Connect ducts according to requirements in Section 233300 "Air Duct Accessories." Install flexible connectors on makeup air supply duct. Weld exhaust-duct connections with continuous liquidtight joint.

N. Install fire-suppression piping for remote-mounted suppression systems according to NFPA 17A, "Wet Chemical Extinguishing Systems."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Perform hood performance tests required by authorities having jurisdiction.
4. Perform fire-suppression system performance tests required by authorities having jurisdiction.

B. Commercial-kitchen hoods will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 233813

SECTION 234100 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pleated panel filters.
   2. V-bank cell filters.
   3. Side-access filter housings.
   4. Filter gauges.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.

   1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
   2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance:
   1. Comply with ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

B. Comply with NFPA 90A and NFPA 90B.

2.2 PLEATED PANEL FILTERS

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

1. Camfill Farr 30/30

2. American Air Filter 300X

B. Capacities and Characteristics:
   1. Face Size: 24 by 24 inches
   2. Depth: 2 inches nominal.
   3. Number of Filters, Wide by High: See Schedule.
   4. Rated Face Velocity: 500 fpm.
   5. Initial Resistance: 0.3-inch wg.
   6. Minimum Efficiency Reporting Value: MERV 8, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.
   7. Access: Side.

C. Media: Non-woven cotton and synthetic fibers coated with nonflammable adhesive.

   1. Welded-wire grid shall be on downstream side to maintain pleat.

D. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

2.3 V-BANK CELL FILTERS

A. Description: Factory-fabricated, disposable, packaged air filters with media angled to airflow, and with holding frames.
   1. Camfil-Farr Durafil ES
   2. American Air Filter Varicel VXL

B. Capacities and Characteristics:
   1. Face Size: 24 by 24 inches
   2. Depth: 12” inches nominal.
   3. Number of Filters, Wide by High: See Schedule
   4. Rated Face Velocity: 500 fpm.
   5. Initial Resistance: .27 inches wg.
   6. Minimum Efficiency Reporting Value: MERV 13, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.
   7. Access: Side.

C. Media: Fibrous material constructed so individual mini-pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.

D. Filter-Media Frames: ABS Plastic.

2.4 SIDE-ACCESS FILTER HOUSINGS

A. Description: Factory-assembled, side-service housings, constructed of galvanized steel, with flanges to connect to duct or casing system.
   1. Camfill Farr
   2. Flanders/Air Seal
   3. American Air Filter

B. Prefilters: Integral tracks to accommodate 2-inch thick, disposable filters.

C. Access Doors: Hinged, with continuous gaskets on perimeter and positive-locking devices, and arranged so filter cartridges can be loaded from either access door.

D. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.

2.5 FILTER GAUGES

A. Diaphragm-type gauge with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Diameter: 4-1/2 inches.
2. Pre Filter: 0- to 1-inch wg.
3. Final Filter: 0- to 2.0-inch wg.

B. Accessories: Static-pressure tips, tubing, gauge connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION OF FILTERS

A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Install filter gauge for each filter bank.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

E. Coordinate filter installations with duct and air-handling-unit installations.

3.2 INSTALLATION OF FILTER GAUGES

A. Install filter gauge for each filter bank.

B. Install filter-gauge, static-pressure tips upstream and downstream from filters. Install filter gauges on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 234100

SECTION 235700 - HEAT EXCHANGERS 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 shell-and-tube and plate heat exchangers.

1.3 DEFINITIONS

A. TEMA: Tubular Exchanger Manufacturers Association.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.5 INFORMATIONAL SUBMITTALS

A. Shop drawing submittal data shall clearly and concisely address all specification requirements listed herein, certification data and shop drawing requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PLATE FRAME HEAT EXCHANGERS

A. Heat exchanger shall be by Bell and Gossett GPX, Alfa-Laval, Armstrong PHE or approved equivalent.

B. Furnish and install plate and frame heat exchanger rated for 150 psi, 225°F in accordance to

ASME Code, Section VIII, Division 1, of the sizes and capacities as scheduled on drawings.

C. Plate shall be pressure corrugated 'herringbone' configuration made of 316 stainless steel with a molded one-piece nitrite gaskets joining each plate.

D. Frame shall be epoxy-coated steel with stainless steel carrying bar. Tightening bolts shall have rolled threads and double width hex nuts.

E. Capacities: see schedule on drawings for requirements.

F. Heat exchanger shall be provided with a stainless steel drain pan.

G. Heat exchanger shall include carrier bar for service and maintenance access.

2.2 SHELL AND TUBE HEAT EXCHANGERS

A. Heat exchanger shall be by Bell and Gossett SU, Alfa-Laval, Armstrong WS or approved equivalent.

B. Steam to water heat exchanger shall be constructed according to ASME Section VIII, Division 1 and shall be rated for 50PSI, 300F Steam in the shell and 150 PSI 300ºF Water in the Tubes.

C. Heat exchanger shall have steel shell, 150 PSI removable cast iron, cast bonnet head; removable tube bundle, brass tube sheet, ¾" copper tubes, brass tube supports and brass baffle plates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

B. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections before equipment installation.

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

3.2 PLATEFRAME HEAT-EXCHANGER INSTALLATION

A. Equipment Mounting:

1. Install heat exchangers on cast-in-place concrete equipment bases.

3.3 CONNECTIONS

A. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.

B. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.

C. Install valves, thermometers, gauges and sensors as indicated on the drawing flow diagram.

END OF SECTION 235700

SECTION 236500 – DRY CLOSED-CIRCUIT COOLER

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 factory-assembled, closed-circuit, induced-draft, counterflow cooling towers.

1.3 DEFINITIONS

A. SCCR: Short-circuit current rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, pressure drop, fan performance data, rating at selected points indicated, and furnished specialties and accessories.
2. Assembled unit dimensions.
3. Weight and load distribution
4. Sound:

    a. Sound pressure levels for operation with fan off, fan at minimum speed, and design speed. If sound requirements are indicated at a specific distance, submit performance using same distance for comparative analysis.

5. Performance curves for the following:

    a. Varying entering-water temperatures from design to minimum in five-degree temperature increments.
    b. Varying water flow rates from design to minimum in increments of 10 percent of flow rate difference between design and minimum flow rates.
    c. Varying fan operation from design to minimum speed in 5 percent speed increments, and with fan off.

6. Fan airflow at design conditions, brake horsepower, and drive losses (indicated in horsepower and percent of brake horsepower).
7. Fan motor electrical characteristics including, but not limited to, speed, voltage, phase, hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
8. Electrical power requirements for dry cooler

B. Shop Drawings:

1. Manufacturer's drawings of assembled dry cooler, control panels, sections, and elevations.
2. Assembled unit dimensions.
3. Assembled unit weight without water.
4. Operating weight and load distribution.
5. Required clearances for maintenance and operation.
6. Sizes and dimensioned locations of piping and wiring connections.
7. Diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For certification required in "Quality Assurance" Article.

B. Field Test Reports: Include startup service reports.

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each dry cooler to include in emergency, operation, and maintenance manuals.

B. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.7 MAINTENANCE MATERIAL SUBMITTALS

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by CTI.

B. CTI Certification: Cooling tower thermal performance according to CTI STD 201.

C. FM Global: Approval and listing in the latest edition of FM Global's "Approval Guide."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Coordinate requirements for multi-piece assembly for shipment. Limit the number of separate pieces for field installation to as few as possible.

B. If factory assembly of multiple pieces is required for testing or other reasons, disassemble cooling tower into major assemblies as required by installation before packaging for shipment.

1. Clearly label each separate package with a unique designation and include with assembly instructions for each complete cooling tower.

2. Install seals on gear-drive assemblies to eliminate oil leakage during shipment if shipped with oil.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of dry cooler that fail in materials or workmanship within specified warranty period:

1. All components of cooling tower.
2. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Evapco

B. Baltimore Air Coil

C. SPX Cooling Technologies

2.2 DESIGN ARRANGEMENT

A. Counterflow design with airflow from all sides and induced-draft, top-mounted axial fan and pressurized pipe distribution.

2.3 CASING AND FRAME

A. Casing Material: Stainless steel, Grade 304.

B. Frame Material: stainless steel, Grade 304.

C. Joints and Seams: Sealed watertight.

2.4 HEAT-EXCHANGER COILS

A. Tube and Tube Sheet Materials: stainless-steel tube and tube sheet.

B. Heat-Exchanger Arrangement:

1. Serpentine tubes; sloped for complete drainage of fluid by gravity.
2. Tubes with extended surface fins if required to achieve performance indicated.

C. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp; sloped for complete drainage of fluid by gravity.

D. Field Piping Connections: Vent, supply, and return.

2.5 FAN AND DRIVE ASSEMBLY

A. Axial Fan: Balanced at the factory.

B. Direct Drive: Fan hub directly connected, and properly secured, to motor shaft.

C. Fan Motor:

1. Motor shall be zero maintenance electronically commutated, ball bearing type with IP55 protection. Motor shall be class F insulated. Motor shall contain integrated PID controller, thermal overload protection, reverse polarity protection, and modbus connectivity 0-10v or 4-20ma shall be the control input. Motor shall be capable of continuous duty within a temperature range of -13 to 149ºF.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine cooling towers before installation. Reject cooling towers that are damaged.

B. Before dry cooler installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting cooling tower performance, maintenance, and operation.

1. Dry Cooler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
2. Verify sizes and locations of concrete bases and support structure with actual equipment.
3. Verify sizes, locations, and anchoring attachments of structural-steel support structures.
4. Verify sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment.

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

3.2 INSTALLATION

A. Install Dry Cooler on support structure.

B. Equipment Mounting:

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Maintain clearances required by governing code.

E. Loose Components: Install components, devices, and accessories furnished by manufacturer with cooling tower, that are not factory mounted.

3.3 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between cooling towers and other equipment to interlock operation as required to achieve a complete and functioning system.

C. Connect control wiring between cooling tower control interface and DDC system for remote monitoring and control of dry cooler.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping; controls; and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
    a. Verify that accessories are properly installed.
    b. Verify clearances for airflow and for dry cooler servicing.
    c. Check for vibration isolation and structural support.
    d. Verify fan rotation for correct direction and for vibration or binding and correct problems.

D. Prepare a written startup report that records the results of tests and inspections.

END OF SECTION 236514.16

SECTION 237313 – MODULAR PACKAGED AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 230100 “Basic Mechanical Requirements” and Section 230500 “Basic Mechanical Materials and Methods” apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

A. This Section includes packaged modular air-handling units with coils for indoor installations as further described herein.

B. Related Sections include the following:

1. Division 23 Section “Motors.”

2. Division 23 Section “Duct Accessories” for dampers used as an integral part of factory-packaged air-handling units specified in this Section.

3. Division 23 Section “Control Systems” for temperature controls, wiring, devices, components, and actuators for dampers furnished under this Section.

4. Division 26 Section “Variable Frequency Motor Controllers” for motor controllers utilized to vary the speed of the fan motors in response to a temperature control signal.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product Data: For each type of modular packaged air-handling unit indicated. Include the following:

1. Certified fan-performance curves with system operating conditions indicated.

2. Certified fan-sound power ratings.

3. Certified coil-performance ratings with system operating conditions indicated.

4. Motor ratings, electrical characteristics, and motor and fan accessories.

5. Material gages and finishes.

6. Filters with performance characteristics.

7. Product data for all specified accessories.

8. Certified enthalpy wheel performance ratings, including efficiencies per ASHRAE 84 guidelines and cross-contamination performance reports.

9. Fan bearing selection criteria to assist in future bearing repairs and/or replacement.

10. Fan/Motor belt drives and sheave combination shall be selected using a Drive Selection Program such as Gates Designflex Pro. Manufacturer shall submit the drive selection program output with the unit submittal.

11. All fans shall be selected with an allowance of 1.5 inches internal static pressure for dirty filters.

C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

D. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

E. Coordination Drawings: Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

F. Source quality-control reports.

G. Field quality-control reports.

H. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

I. Warranty: Air-handling units shall have a 1-year warranty on all parts

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain modular packaged air-handling units through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of factory-packaged air-handling units and are based on the specific system and model indicated. Refer to Division 23 Section “Basic Mechanical Requirements” for guidelines concerning the use of other systems or models.

C. NFPA Compliance: Factory-packaged air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, “Installation of Air Conditioning and Ventilating Systems.”

D. AHRI Certification: Factory-packaged air-handling units and their components shall be factory-tested according to the applicable portions of AHRI 430 and shall be listed and bear the label of the Air-Conditioning Heating and Refrigeration Institute (AHRI).

E. AHRI Certification: Energy-recovery product shall be formally certified under the AHRI 1060 certification program *ANSI/AHRI Standard 1060 2005 Standard for Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation* and shall bear the seal of the AHRI logo.

F. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2010, Section 6 – “Heating, Ventilating, and Air-Conditioning.”

G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2010, Section 5 – “Systems and Equipment” and Section 7 – “Construction and Startup.”

H. Fan Performance Ratings: Rate according to AMCA 210, “Laboratory Methods of Testing Fans for Rating.” In addition, all airfoil fans shall comply with AMCA standard 99-2408-69 and 99-2401-82 and shall bear the AMCA Seal.

I. Sound Power Level Ratings: Rate according to AMCA 301, “Methods for Calculating Fan Sound Ratings from Laboratory Test Data” and AMCA 300, “Reverberant Room Method for Sound Testing of Fans.” Fans shall bear AMCA-certified sound ratings seal.

J. Sound Power Level Ratings: Rate according to AHRI 260-2001, “Sound Rating of Ducted Air Moving and Conditioning Equipment.”

K. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.

L. UL and NEMA Compliance: Provide motors required as part of air-handling units that are listed and labeled by UL and comply with applicable NEMA standards.

M. Comply with NFPA 70 for components and installation.

N. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled. The terms “Listed” and “Labeled” are defined in the National Electrical Code, Article 100. Listing and Labeling Agency Qualifications: A "National Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.5 COORDINATION

A. Coordination: Coordinate layout and installation of factory-packaged air-handling units with piping and ductwork and with other installations.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Comply with ASHRAE 62, Section 7 (practices to be followed during construction and startup). Protect equipment from moisture by appropriate in-transit and on-site procedures.

B. Provide shrink-wrap around unpainted units. The membrane shall cover entire air handling unit during shipping and storage. Cover equipment, regardless or size or shape. Tarping is not acceptable.

C. Shrink-wrap equipment, including electrical components, for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust and corrosion. Keep equipment clean and dry.

D. Deliver air-handling unit as a factory-assembled module with shipping splits only as necessary and with protective crating and covering.

E. Store per air handling unit Manufacturer's written recommendations. Store air handling unit indoors in a warm, clean, dry place where units will be protected from weather, construction traffic, dirt, dust, water, moisture. If units will be stored for more than 6 months, follow manufacturer's instruction for long-term storage.

F. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate equipment scheduling with project phasing. Air handlers located in the basement to utilize basement roof hatch for entry. Air handlers serving floors 2-Penthouse shall utilize freight elevator for installation.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents for each modular air-handling unit.

1. Filters: Furnish one (1) additional set for each central station air-handling unit. This shall include complete sets of pre-filters and final filters as described below for each air handling unit, energy recovery unit and blower coil unit.

2. Gaskets: Furnish one (1) additional complete set for each access door on each modular air-handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Trane

2. Or Pre-Bid Approved Equal from:

a. McQuay International, division of Daikin Industries, Ltd.
b. York, division of Johnson Controls, Inc.

2.2 MANUFACTURED UNITS

A. General Description: Factory-assembled, 2-inch solid double-wall units consisting of fans, motor and drive assembly, coils, dampers, plenums, filters, and condensate pans. Refer to Schedule Sheet and plans for each unit configurations and individual components.

B. Pressure Class: Meet requirements of this Specification at all of the following water column static pressure conditions:

1. Exterior Cabinet Wall: 6-inch positive and 4-inch negative water column static pressure differential across casing of the air-handling unit; or the largest static pressure capability of the unit fan(s) at any point on their operating curve; whichever is greater.

2. Internal Cabinet Walls between the Economizer and Mixing Box Sections: 10-inch static pressure differential (i.e., 4-inch positive and 6-inch negative) water column across this internal compartment wall of the air-handling unit; or the largest static pressure capability of the unit's supply and return fans at any point on their operating curves; whichever is greater.

3. Structural Performance: Casing panels shall be self-supporting and capable of withstanding static pressures indicated above, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.

2.3 CABINET

A. Materials: Formed and reinforced solid double-wall, insulated, G-90 mill galvanized steel wall and top panels, fabricated to allow removal for access to internal parts and components without affecting the structural integrity of the unit, with joints between sections sealed. The housing shall be supported by an all welded, epoxy-painted structural base with lifting lugs.

   1. Outer Casing Framing: Galvanized steel, 16-gage;

   2. Outer Casing Panels: Galvanized steel, minimum 18-gage.

   3. Inner Casing: Galvanized steel, 20-gage solid in all sections unless otherwise noted.

   4. Floor Plate: Galvanized steel, 14-gage solid. Floor must be capable of supporting maintenance personnel.

B. Base Rail: The entire unit shall be supported on a 14-gage galvanized steel rail channel. Minimum rail height shall be 6-inches unless otherwise noted on Drawings. Provide integral lifting lugs.

C. Insulation: Glass-fiber insulation, complying with ASTM C1071 and NFPA 90A.

   1. Thermal Performance: k-value 0.26 BTU-in/(hr-sf-degF) at 75°F mean temperature.

   2. Thickness: 2 inches (50 mm), 3-pound density having a minimum R-value of 12 ft2-hr-F/Btu ft, complying with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," for insulation

   3. Option: Closed-cell insulation of at least 2-pound density and R-12 thermal performance will also be acceptable.

   4. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C411.

   5. Location and Application: Encased between outside and inside casing.

   6. All connecting channels shall be insulated to prevent sweating.

   7. Insulate frame in the same manner as panels, roof and floors.

D. Access Doors: Same materials and finishes as cabinet and complete with hinges, latches, handles, and gaskets. All doors shall have direction of swing chosen to provide a seating head pressure against the door gasket.

1. The following locations, and other unit sections as indicated on Drawings, shall have access doors sized and located to allow periodic maintenance and inspections. Access doors shall be on the same side of the unit as the coil connections unless indicated otherwise.

    a. Fan Section, motor side.
    b. Access Section.
    c. Filter Section.

2. Latches: Minimum of two (2) heavy-duty industrial-type roller cam mechanisms per door, operable from inside and outside.

3. Hinges: A minimum of two heavy-duty stainless-steel piano hinge. Door hinges shall allow full 180-degree swing.

4. Gasket: 3/8 inch bulb-type neoprene gasket complying with UL 723, applied around entire perimeters of panel frames.

5. Size: At least 24 inches (610mm) wide by full height of unit casing, but need not be taller than 60 inches (1500 mm) unless otherwise noted on Drawings.

6. Not Acceptable: Access panels which do not remain attached to the unit when opened. Bolted or screwed access panels.

7. Note there are units that use access doors to allow access through unit to opposite side of unit. Refer to Drawings for these units and the access door locations. These units the access doors shall be located on each side of the unit section. Access latches must be accessible from inside and outside of unit. These access doors shall be a minimum 24 inches (610 mm).

E. Drain Pans: Readily cleanable, formed sections of stainless steel sheet complying with ASHRAE Standard 62. Fabricate pans in sizes and shapes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) when units are operating at maximum catalogued face velocity across cooling coil. Pans shall be sloped in two planes at a minimum of two percent slope for complete drainage to a single outlet without standing water.

1. Double-Wall Construction: Fill space between walls with 2-inches insulation and seal moisture tight having a minimum R-value of 12 ft2-hr-F/Btu ft, complying with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," for insulation

2. Drain Connection: Same side of unit as coil connection side, unless noted otherwise; pre-piped to exterior of unit. Locate at lowest point of pan and size to prevent overflow, but not smaller than NPS 1¼ (DN 32) in any case. Terminate with threaded nipple.

3. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil.

4. All portions of the drain pan, including intermediate pans and any hardware subject to contact with condensate, shall be constructed of Type 304 stainless steel.

5. Fasteners: All fasteners exposed to weather shall be corrosion-resistant.

6. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1. A minimum of 14 inches.

7. Depth: A minimum of 2 inches (50 mm) deep.

8. Provide drain pan under the complete width and length of cooling coil section.

9. Insulate plumbing associated with drain pan and connections.

10. Provide a minimum of 1 inch clearance between the drain pan and any coil casing, coil support or any other obstruction.

2.4 FAN SECTION

A. Refer to Schedule Sheets for acceptable fan types. Only fan types shown on Schedules Sheets are acceptable. Substitutions will not be allowed. Refer to the following section for specifics for each type of fan. The fan section described below shall apply for all supply, return and exhaust fan sections of a Modular-Packaged Air-Handling Units. Refer to Drawings for required unit sections.

B. Fan-Section Construction: Fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan scroll, wheel, shaft, bearings, and motor on structural-steel frame, with frame mounted on base with vibration isolation.

1. Install fans on housed spring vibration isolators, minimum 2-inch (50-mm) static deflection, with seismic snubbers. Vibration isolators shall be Mason Industries Model SLF or equal.

2. Install duct flexible connector at point of connection of fan discharge to the unit cabinet.

C. Fans, General: All fans shall be housed, double-width, double-inlet type with airfoil blades; unless another type of fan is expressly indicated on Drawings or elsewhere in these Specifications.

D. Fan Speed: Fans shall be selected with at an operating rate not exceeding 1800 RPMS unless expressly indicated on Drawings.

E. Centrifugal Fan Housings: Formed- and reinforced-steel panels to make curved scroll housings with shaped cutoff, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.

1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

2. Performance Class: AMCA 99-2408, Class I, II or III as scheduled; Class I if not otherwise indicated. If the fan selection indicates an operating point within 10 percent of the maximum operational rpm limit for the fan class indicated by the selection point, the fan manufacturer shall provide a fan of the next-higher class designation.

3. Horizontal Flanged Split Housing: Bolted construction.

4. Plug Fans: With steel cabinet. Fabricate without fan scroll and volute housing.

F. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

G. Airfoil-Fan Wheels: Required unless otherwise indicated. Steel construction with smooth-curved inlet flange, heavy backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

H. Plenum “Plug” Fans: Permitted only where expressly indicated on Drawings or elsewhere in these Specifications. Steel construction with smooth-curved inlet flange, heavy backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws. Fabricate without fan scroll and volute housing. Single-width, single-inlet style.

I. Shafts: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Hot Roiled solid steel, turned, ground, and polished with keyway and ring gauged for accuracy. Ship with a protective coating of lubricating oil.

2. Designed to operate at no more than 70 percent of first critical speed at top of fan’s speed range.

3. Shafts shall be sized for the critical speed of at least 1.25 times the maximum speed for the class.

J. Grease-Lubricated Shaft Bearings: Heavy duty, grease lubricated, self-aligning, pillow-block-type, ball or roller bearings with the following:

1. Bearing Rating Life: ABMA 9, L10 of 200,000 hours at the maximum class RPM.

2. Bearing extended copper lubrication lines and grease fittings shall be extended to, and mounted adjacent to, unit access door(s) for easy accessibility.

K. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation and with 1.5 service factor based on fan motor.

1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

2. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

3. Belts: Oil resistant, non-sparking, and non-static; matched for multiple belt drives. Provide multiple drives on belt driven fans with motor 10 HP or greater.

4. Motor Mount: Adjustable for belt tensioning.

L. Fan-Section Source Quality Control:

1. Sound Power Level Ratings: Comply with AHRI 260-2001, “Sound Rating of Ducted Air Moving and Conditioning Equipment.” Test fans according to AMCA 300, “Reverberant Room Method for Sound Testing of Fans.”

2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, “Laboratory Methods of Testing Fans for Rating.”

3. Sound level shall not exceed 85db, three (3) feet from unit.

2.5 MOTORS

A. General: Refer to Division 23 Section “Motors” for general requirements, which are fully applicable to the work of this Section as if repeated herein.

B. Motor Sizes: Minimum size as indicated, but larger if necessary so driven load will not require motor to operate in service factor range at design point, and larger if necessary so driven load will not require motor to operate beyond the service factor at any point on the fan curve.

C. Location: Motor, drive, and access door shall be on the same side of the fan as the coil connection side, unless otherwise indicated. Provide motor on an adjustable base, inside the air handling unit housing. Motors external to the air-handling unit housing are not acceptable.

D. Inverter-Ready Motors are required for all fans indicated to be controlled by a variable frequency drive.

E. Noise Rating: Quiet.

F. Starters, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

G. Variable Frequency Drives shall be furnished and installed by Division 26.

2.6 HYDRONIC COILS

A. Coil Sections: Individual, insulated casings for each heating coil and cooling coil separately. Design and construct to facilitate removal and replacement of coil for maintenance and to assure full airflow through coils.

B. Coil Casing: Same as cabinet construction for heating coil sections; same as cabinet construction but with all stainless steel materials for cooling coil sections.

C. Circuit Arrangement: Self-draining and self-venting coil fabricated according to AHRI 410. Number of rows shall be determined by manufacturer to meet scheduled performance requirements. Unless noted otherwise, do not exceed 2 rows for heating coils or 6 rows for cooling coils. Refer to equipment schedules. Where coil selection requires more than an 8 roil coil provide two (2) independent coils with an access section with doors in between the coils. If required unit dimensions must be approved by Engineer for approval.

D. Piping Connections: Threaded on same side. Coil connections shall be on the side of the unit indicated on the Drawings.

E. Tubes: Copper 5/8-inch O.D. with 0.025-inch minimum wall. Select coils for not less than 1 fps water velocity and not more than 6 fps water velocity.

F. Provide coils with copper tube return bends with the final minimum thickness of 0.035 inch for 5/8 inch diameter tubing.

G. Fins: Aluminum of minimum thickness 0.006-inch. Spacing shall not exceed 8 per inch for heating coils or 10 per inch for cooling coils.

H. Fin and Tube Joint: Mechanical bond created via thermal expansion.

I. Headers: Non-ferrous, such as seamless copper tube with brazed joints, with drain and air vent tappings. Headers and return bends shall be enclosed within the air handling unit casing.

J. Frames: Stainless steel, 0.0625-inch (1.58 mm) is required for cooling coils. Galvanized-steel channel frame, 0.052-inch (1.3 mm) is acceptable for heating coils.

K. Ratings: Design tested and rated according to ASHRAE 33 and AHRI 410.

L. Working-Pressure Ratings: 200 psig (1380 kPa), 325ºF (163 C).

M. Source Quality Control: Factory test coils to 315 psig (2070 kPa) air pressure under warm water, according to ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."

N. Insulate gap between coil stub out connection and air handling unit casing with a spool shaped sleeve grommet. Adhesive rings applied to the casing walls are not acceptable.

2.7 UV-C EMITTER

A. See specification 230566 for UV-C Emitter requirements.

2.8 INLET PLENUM SECTION:

A. Provide inlet plenum section for connection to outside air duct. Provide inlet plenum with factory mounted damper where indicated on the Drawings. Refer to Division 23 Section “Duct Accessories” for specification of automatic control dampers, whose requirements govern as if fully reproduced herein.

1. It is the intent of this specification that damper actuators will be furnished and field-installed as the work of Division 23 Section “Control Systems” as part of an overall building temperature control system.

2.9 FILTER SECTION

A. Provide solid double-wall, insulated, galvanized steel casing for filter section to match cabinet construction indicated above, with magnehelic gauges for indicating the operating pressure drop across each filter bank (two magnehelic gauges are required for air handling unit). Magnehelic gauges shall be installed with a manifold and valves to isolate lines to each side of the filter. Magnehelic gauges shall be Dwyer Model 2002 with air filter gauge accessory package.

B. Pre-Filters: Pre-Filters shall be 2 inch thick, high density glass micro fibers laminated to an all glass woven mesh backing with welded wire media support grid, clean airflow resistance of 0.10 inch wg at face velocity of 300 fpm and ASHRAE 52.1 filter-arrestance efficiency of 70 to 82 percent. Filters shall comply with NFPA 90A. Provide filter media holding frames arranged for flat orientation. Filter shall be Farr type 30/30 or equal by American Air Filter. All filters shall be 24 inches by 24 inches or 24 inches by 12 inches, where possible.

C. Final Filters: Final filters for supply airstream shall be 12 inch thick, cartridge type filters with filter media consisting of high density microfine glass fibers, laminated to a reinforcing backing. Filter media shall have an average efficiency of 60-65% on ASHRAE Test Standard 52.1, and it shall

have an arrestance of not less than 97% on that same standard. Provide filter media holding frames arranged for flat orientation. Filter shall be Farr RIGA-FLO 15 or equal by American Air Filter. All filters shall be 24 inches by 24 inches or 24 inches by 12 inches, where possible.

2.10 AIR HANDLING UNIT ACCESSORIES

A. Field installed lights shall be installed in fan and access sections. Lights shall include an on/off toggle switch.

B. Field installed UV light shall be installed in the cooling section. UV light shall include toggle switch and door interlock.

2.11 BLOWER COIL UNITS

A. General Description: Factory assembled, consisting of fan, motor and drive assembly, chilled water cooling coil, hot water heating coil, filters and drain pans.

B. Cabinet: Cabinet shall be constructed of minimum 18-gauge galvanized steel, insulated with 3/4-inch, 1-1/2 lb. density, fire-resistant and odorless faced glass fiber material to provide thermal and acoustical insulation.

C. Fans: Fan shall be forward curved, centrifugal blower type, equipped with heavy-duty adjustable speed V-belt drive. The fan shaft shall be supported by heavy-duty, permanently lubricated and sealed ball bearings.

D. Motors: Motor shall be open drip-proof with permanently sealed ball bearings; internal current and thermal overload protection, a minimum 1.15 service factor and 56 frame resilient base.

E. Coil Sections: Provide insulated, galvanized steel casings for cooling coil and heating coil. Design and construct to facilitate removal and replacement of coils for maintenance and to assure full airflow through coils.

F. Coil Construction: Rigidly supported across full face, pitched to allow drainage.

1. Coil Casing: Same as cabinet construction, but with all stainless steel materials for cooling coil sections. Coil header and return bend casings for chilled water shall be stainless steel.

2. Coil Construction: Rigidly supported across full face, pitched to allow drainage.

3. Circuit Arrangement: Self-draining and self-venting coil fabricated according to ARI 410. Number of rows shall be determined by manufacturer to meet scheduled performance requirements unless noted otherwise.

4. Piping Connections: Threaded on same side. Coil connections shall be on the side of the unit indicated on the Drawings.

5. Tubes: Copper, 5/8" O.D. with 0.025" minimum wall thickness. Select coils for not less than 1 fps water velocity and not more than 6 fps water velocity.

6. Fins: Aluminum of minimum thickness 0.006”. Spacing shall not exceed 8 per inch for heating coils nor 10 per inch for cooling coils.

7. Fin and Tube Joint: Mechanical bond created via thermal expansion.

8. Headers: Chilled water coil header shall be stainless steel. Heating coil shall be non-ferrous, such as seamless copper tube with brazed joints. Provide drain and air vent tappings. Headers and return bends shall be enclosed within the air handling unit casing.

9. Frames: Stainless steel, 0.0625 inch (1.58 mm) is required for cooling coils. Galvanized-steel channel frame, 0.052 inch (1.3 mm) is acceptable for heating coils.

10. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.

11. Working-Pressure Ratings: 200 psig (1380 kPa), 325ºF (163 C).

12. Source Quality Control: Factory test coils to 315 psig (2070 kPa) air pressure under warm water, according to ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."

13. Drain Pan: Provide stainless steel, insulated pan, sloped in both directions and fully drainable.

G. Filters: 2-inch- (50-mm-) thick, high density glass micro fibers laminated to an all glass woven mesh backing with welded wire media support grid, clean airflow resistance of 0.10 inch wg (25 Pa) at face velocity of 300 fpm (1.52 m/s), and ASHRAE 52.1 filter-arrestance efficiency of 70 to 82 percent. Filters shall be Farr 30/30 or equal by American Air Filter. All filters shall be 24 inches by 24 inches or 24 inches by 12 inches, where possible.

H. Unit Controls: Controllers for blower coil units shall be furnished and installed as work of Section 230900 "HVAC Instrumentation and Controls."

I. Condensate Overflow Switch: Provide unit with condensate overflow switch factory wired for field mounting in an auxiliary drain pan to shut off the supply fan in the event of condensate overflow from the main pan to the auxiliary pan.

J. Disconnect Switch: Provide a factory-installed and pre-wired NEMA 1 non-fused disconnect switch.

K. Units shall sit on field fabricated stand. Refer to Drawings for stand requirements.

L. All piping connections, filter access, controls shall be from one side of the unit.

M. Provide bottom return plenum section. Plenum construction shall be the same as unit construction above. Plenum shall be fully insulated. Return plenum will have a solid bottom and back panel with front opening. Blower coil unit shall sit directly on top of plenum return. Plenum return shall sit on field fabricated concrete housekeeping pad.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Install factory-packaged air-handling units level and plumb, according to manufacturer's written instructions.

B. Access and service shall comply with International Mechanical Code section 306. Arrange installation of units to provide access space around air-handling units for service and maintenance. A minimum 48 inches (1220 mm) clearance is required on side for fan access, filter access and coil access. A minimum of 24 inches (610 mm) of access space shall be provided on opposite side of unit from a where motor, coil, and filter access is provided. Provide Manufacturer's recommended motor, coil and filter access if more than described above.

C. Adjust damper linkages for proper damper operation.

D. Maintain specified filters in air handling units throughout construction to prevent dust and debris from entering of units.

3.3 HOUSEKEEPING BASES:

A. Install floor-mounted units on concrete housekeeping bases. See Division 23 Section "Basic Mechanical Materials and Methods" for concrete base materials and fabrication requirements.

B. Support variable-volume central station air handling units on concrete housekeeping bases using neoprene pads. Secure units to anchor bolts installed in concrete housekeeping base. Note ventilation air handling units will be supported directly on the mechanical room floors (no concrete housekeeping pad). Support those units on neoprene pads and secure to floor with anchor bolts.

C. Coordinate size of housekeeping bases with Division 03 installer to match actual unit sizes provided. Base shall be 4-inches (100 mm) larger than overall dimensions of supported unit on all sides. Thickness shall be as indicated, but not less than 4 inches in any case.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

1. Coil piping shall not block access doors.

2. Coil piping shall offset beyond the limits of the coil pull access space in as short a distance as practical, to minimize the amount of pipe disassembly required to accomplish coil removal. All coil service valves, control valves, balance valves, strainers, and other appurtenances shall be installed outside the limits of the coil pull access space.

C. Connect condensate drain pans using NPS 1¼ (DN 32), Type L copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

D. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.

1. Hydronic piping shall be connected to hydronic coils in a counterflow arrangement, such that direction of water flow is opposite the direction of air flow.

E. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.

F. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls. Connect wiring and ground equipment according to Division 26 Sections.

1. Connect fan motors to wiring systems and ground. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

G. Temperature control wiring and interlock wiring is specified in Division 23 Section "Control Systems."

3.5 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean modular packaged air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Remove paint splatters and other spots. Repair damaged finish to match original finish. Vacuum clean fan wheels, cabinets, and coils entering air face. Comb all hydronic coils straight.

C. After completing system installation and testing, adjusting, and balancing modular packaged air-handling and air-distribution systems, clean filter housings and install new filters.

3.6 COMMISSIONING

A. Final Checks before Startup: Perform the following before startup:

1. Verify that shipping, blocking, and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.

3. Verify integrity of condensate trap for positive or negative pressures operation.

4. Verify filter gages are set to zero.

5. Perform cleaning and adjusting specified in this Section.

6. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

7. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

8. Comb coil fins for parallel orientation.

9. Install new filters of the specified type in each air handling unit.

10. Verify that manual and automatic volume control, and fire dampers in connected ductwork systems are in fully open position.

END OF SECTION 237313

SECTION 238123.11 –COMPUTER-ROOM AIR-CONDITIONERS, FLOOR-MOUNTED UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes floor-mounted, computer-room air conditioners of 6 tons and smaller.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For computer-room air conditioners.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers of the items involved.

B. Seismic Qualification Data: Certificates, for computer-room air conditioners, accessories, and components, from manufacturer.

C. Field quality-control reports.

D. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Humidifiers: Manufacturer's standard, but not less than three years from date of Substantial Completion.
3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Vertiv Liebert

B. Data-Aire inc

C. Stultz

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

D. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

2.3 MANUFACTURED UNITS

A. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for vertical floor mounting in upflow or downflow configuration.

B. Cabinet and Frame: Welded tubular-steel frame with removable steel panels with baked-enamel finish, insulated with 1-inch-thick duct liner.

1. Floor Stand: Welded tubular steel, with adjustable legs and vibration isolation pads. Contractor to confirm height prior to submitting.
2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Unit with one way [powder-coated insulated air distribution plenum.

C. Supply-Air Fan: EC Plug Fan

D. Refrigeration System:

1. Compressor: Digital Scroll,with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
2. Refrigeration Circuit:

a. Low-pressure switch.
b. Manually reset, high-pressure switch.

c. Thermal-expansion valve with external equalizer.
d. Sight glass with moisture indicator.
e. Service shutoff valves.
f. Charging valves.
g. Hot-gas bypass.
h. Refrigerant charge.

3. Refrigerant: R-410A.
4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins, with two circuits, each with solenoid valve.
5. Refrigerant line sets.
6. Refrigerant line-sweat-adapter kit to permit field brazing of refrigerant lines.

a. Mount stainless-steel drain pan having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir under coil assembly.

7. Remote Air-Cooled Refrigerant Condenser:

a. Integral, copper-tube aluminum-fin coil.
b. Condenser with surge protection device (SPD) and locking disconnect in the enclosed electrical panel section.

8. Fan: Direct-drive, variable-speed propeller type.
9. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

E. Electric-Resistance Reheat Coil:

1. Finned-tube electric elements with contactor and high-temperature-limit switches.
2. 2- stage control the reheat elements providing precise temperature control.

F. Filter: 2-inch- thick, disposable, pleated, glass-fiber media.
1. Filter Minimum Efficiency Reporting Value and Average Arrestance:

a. MERV Rating: Merv 8 and corresponding average arrestance according to ASHRAE 52.2.

G. Infrared Steam Humidifier: Self-contained, high intensity quartz lamps mounted above and out of the water supply with stainless steel pan.

1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
2. Control: Fully modulating to provide gradual modulation from zero to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
3. Drain Cycle: Field-adjustable drain duration and drain interval.

H. Disconnect Switch: Locking disconnect with handle accessible with the door closed.

I. Disconnect Switch: Non-locking, non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

J. Control System:

1. Microprocessor unit-mounted panel.

2. Fan contactor.
3. Compressor contactor.
4. Compressor start capacitor.
5. Control transformer with circuit breaker.
6. Solid-state temperature- and humidity-control modules.
7. Humidity contactor.
8. Time-delay relay.
9. Heating contactor.
10. Smoke sensor.
11. High-temperature thermostat.

K. Fan Motors:
1. Electronically Commutated ECM Motor

2.4 CAPACITIES AND CHARACTERISTICS

A. See Schedule for Capacities

PART 3 - EXECUTION

3.1 INSTALLATION

A. Layout and install computer-room air conditioners and suspension system coordinated with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Install computer-room air conditioners coordinated with computer-room access flooring Installer.

C. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances. Install according to AHRI Guideline B.

D. Computer-Room Air-Conditioner Mounting: Install using elastomeric pads. Comply with requirements for vibration isolation devices specified in

3.2 CONNECTIONS

A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to computer-room air conditioners, allow space for service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

D. After startup service and performance test, change filters and flush humidifier.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION 238123.11

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

    a. For Compressor: Five year(s) from date of Substantial Completion.
    b. For Parts: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Mitsubishi Electric Sales Canada Inc.
2. Samsung HVAC.
3. Trane.

2.2 INDOOR UNITS

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
4. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
5. Fan Motors:

    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
    c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Filters: Permanent, cleanable.
8. Condensate Drain Pans:

    a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
    b. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

B. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.

2.3 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a. Compressor Type: Scroll.
    b. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Automatic-reset timer to prevent rapid cycling of compressor.

B. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

C. Drain Hose: For condensate.

D. Monitoring:

1. Monitor constant and variable motor loads.
2. Monitor variable-frequency-drive operation.
3. Monitor economizer cycle.
4. Monitor cooling load.
5. Monitor air distribution static pressure and ventilation air volumes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
3. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply[**and return**] ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 238239 – IN-ROOM TERMINAL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following types of in-room terminal equipment:

1. Heating and cooling fan-coil units.

1.2 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. Section 20 0800 “Seismic Protection,” Section 23 0100 “Basic Mechanical Requirements,” and Section 23 0500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product, include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include location and size of each field connection.

4. Include details of anchorages and attachments to structure and to supported equipment.

5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.

6. Indicate location and arrangement of piping valves and specialties.

7. Indicate location and arrangement of integral controls.

C. Wiring Diagrams: Power, signal, and control wiring.

D. Seismic Qualification Certificates: Submit certification that in-room terminal units, accessories, and components will withstand seismic forces defined in Division 20 Section “Seismic Protection.” Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Include detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control reports.

F. Operation and Maintenance Data: For in-room terminal units to include in emergency, operation, and maintenance manuals.

1.5 EXTRA MATERIALS

A. Furnish extra filters described in Division 23 Section “Air Filters” that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.6 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - “Systems and Equipment” and Section 7 - “Construction and Startup.”

B. Airstream Surfaces: All surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - “Heating, Ventilating, and Air-Conditioning.”

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 IN-ROOM TERMINAL EQUIPMENT, GENERAL (ALL UNITS)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hydronic In-Room Terminal Equipment:

a. Trane Technologies plc.

b. Daikin Applied Americas Inc.
c. Johnson Controls Inc.

B. Capacities and Characteristics: As Scheduled on the Drawings.

2.2 HEATING AND COOLING FAN-COIL UNITS

A. Description: Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 2016.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fan Coil Unit Configurations: Ducted Concealed, Horizontal exposed and vertical exposed. If schedule indicates both hydronic heating and cooling, provide four-pipe configuration with two physically separate and independent hydronic coils.

D. Coil Section Insulation: 1-inch-thick glass fiber complying with ASTM C1071 and attached with adhesive complying with ASTM C916. Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Drain Pans: Polymer type sloped pan. Fabricate pans and drain connections to comply with ASHRAE Standard 62.1.

F. Chassis: Galvanized steel with removable access panel on concealed units, Baked-enamel finish and removable access panel for exposed units. Floor-mounting units shall have leveling feet.

G. Cabinets: Galvanized steel with baked-enamel finish in manufacturer's standard paint color.

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220°F. Include manual air vent and drain.

1. Hydronic Coil Tubing: Minimum ½-inch diameter with minimum 0.016-inch wall thickness.

2. Hydronic Coil Fins: Minimum 0.006-inch fin thickness. Spacing shall not exceed 10 per inch for heating coils nor 12 per inch for cooling coils.

I. ECM Direct Drive Fans: Double width, forward curved, centrifugal; with 0-10 V speed signal input.

J. Electrical Connection: Factory-wired motors for a single field connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive in-room terminal equipment for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly, seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Sections.

B. Install in-room terminal equipment to comply with NFPA 90A.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Install new filters in each cabinet unit heater within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Section “Hydronic Piping.” Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves, unions, fittings, and other specialty items as indicated by detail on the Drawings.

C. Install piping adjacent to machine to allow service and maintenance.

D. Comply with safety requirements in UL 1995.

E. Connect wiring and ground equipment according to Division 26 Sections.

3.4 FIELD QUALITY CONTROL

A. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

B. Operate electric heating elements through each stage to verify proper operation and electrical connections.

C. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment. Units will be considered defective if they do not pass tests and inspections. Prepare test and inspection reports.

END OF SECTION 238239