ADDENDUM No. 1

TO THE

CONTRACT DOCUMENTS FOR CONSTRUCTION OF

Public Safety Center 3rd Floor Improvements

PROJECT # 24ARPA12

THIS ADDENDUM IS HEREBY MADE A PART OF THE CONTRACT DOCUMENTS DATED OCTOBER 10, 2024, TO THE SAME EXTENT AS THOUGH IT WERE ORIGINALLY INCLUDED THEREIN.

ISSUED THIS 11th DAY OF OCTOBER, 2024.

CITY OF ROSEBURG
PUBLIC WORKS DEPARTMENT
900 SE DOUGLAS AVENUE
ROSEBURG, OREGON 97470
(541) 492-6730

This addendum forms a part of the Contract Documents and modifies the original Bidding Documents dated October 10, 2024 as noted below. Acknowledge receipt of this addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.

GENERAL INFORMATION

Non-Mandatory Prebid Meeting will be held on Thursday, October 17, 2024 at 2:30 pm. Location: Lobby at 700 SE Douglas Ave.

SPECIFICATIONS

ADD The following Technical Specification attached Technical Specifications in their entirety.

Division 08:

Section 08 5959 Service Window

Division 21:

Section 21 0500 General Fire Protection Provisions
Section 21 1313 Wet-Pipe Sprinkler Systems

Division 22:

Section 22 0500 General Plumbing Provisions
Section 22 0523 Valve for Plumbing Piping
Section 22 0529 Hangers and Supports for Plumbing Piping and Equipment
Section 22 0553 Identification for Plumbing Piping and Equipment
Section 22 0719 Plumbing Piping Insulation
Section 22 1000 Plumbing Piping
Section 22 1119 Domestic Water Piping Specialties
Section 22 1319 Sanitary Waster Piping Specialties
Section 22 4200 Commercial Plumbing Fixtures

Division 23:

Section 23 0500 General HVAC Provisions
Section 23 0513 Common Motor Requirements for HVAC Equipment
Section 23 0529 Hangers and Supports for HVAC Piping and Equipment
Section 23 0548 Vibration and Seismic Controls for HVAC
Section 23 0553 Identification for HVAC Piping and Equipment
Section 23 0593 Testing, Adjusting, and Balancing for HVAC
Section 23 0713 Duct Insulation
Section 23 0719 HVAC Piping Insulation
Section 23 0922 General Automatic Controls for HVAC
Section 23 2300 Refrigerant Piping and Specialties

Section 23 3113 Metal Ductwork
Section 23 3300 Air Duct Accessories
Section 23 3423 HVAC Power Ventilators
Section 23 3713 Air Outlets and Inlets
Section 23 3723 HVAC Gravity Ventilators
Section 23 4100 Particulate Air Filtration
Section 23 8129 Variable-Refrigerant-Flow HVAC System

END OF ADDENDUM NO. 1

Ryan Herinckx
Project Manager
Issued October 11, 2024

SECTION 08 5659

SERVICE WINDOWS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior manually operated window system.

1.2 RELATED REQUIREMENTS

A. Section 01 3000 – Administrative Requirements: Submittal review procedures.

B. Section 01 6000 – Product Requirements: Substitution request procedures.

C. Section 01 7000 – Execution and Closeout Requirements: Closeout procedures.

D. Section 06 100 – Rough Carpentry: Framing for rough opening.

1.3 REFERENCE STANDARDS

A. ASTM E119-98 Standard Test for One-Hour Fire-Rating of Building Construction and Materials.

B. ISO 9001:2015 Quality Management System.

C. NIJ Standard 0108.01 – Type III-A.

D. OSSC - Oregon Structural Specialty Code, latest edition.

1.4 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data

1. Submit manufacturer's product data and installation instructions.

C. Shop Drawings

1. Certificates

a. Demonstrate the product meets or exceeds the required ballistic resistance rating.

D. Manufacturer’s Instructions

1.5 QUALITY ASSURANCE

A. Quality Standards

B. Qualifications

1. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site

1. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier.

B. Storage

1. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic and other causes.

1.7 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUALLY OPERATING SERVICE WINDOW

A. Product and Manufacturer – Basis of Design

1. "Manual DV Deluxe Service Window with Bottom Track" by CRL.
2. Other Acceptable Products and Manufacturers
    a. Ready Access
    b. Substitutions: See Section 01 6000 – Product Requirements.

B. Description

1. Horizontally sliding, manually operating service windows with frame all around.

C. Dimensions

1. Nominal Size: 48 in. x 48 in.
    a. Actual size: 47 3/4 in. high by 47 1/2 in. wide.
2. Frame Depth: 4 in.
3. Frame Width: 2 5/8 in.

D. Materials

1. Glazing
    a. 1/4 in. clear tempered glass.
2. Frame
    a. Aluminum.

E. Finishes

1. Satin Anodized.

2.2 ACCESSORIES

A. Fasteners: Manufacturer recommended security fasteners. Utilize fastener that require two types of tools to operate fasteners.

B. Sealants: As indicated in Section 07 92 00 Joint Sealants.

C. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify field dimensions of opening prior to fabrication of transaction window.

B. Coordinate structural requirements to ensure proper attachment and support.

3.2 INSTALLATION

A. Install window(s) in accordance with manufacturer's recommendations and approved shop drawings.

B. Where dissimilar metals will be in contact, protect against galvanic action by painting contact surfaces with primer or by apply sealant or tape recommended in writing by window manufacturer.

C. Provide required support and securely fasten and set windows plumb, square, and level without twist or bow.

3.3 CLEANING

A. Clean security window surfaces after installation, avoiding damage to finishes. Remove excess glazing and sealant compound and dirt.

3.4 PROTECTION

A. Protect window(s) damage during construction operations. If damage occurs, remove and replace as required to provide windows in their original, undamaged condition.

END OF SECTION

SECTION 21 0500

GENERAL FIRE PROTECTION PROVISIONS

PART 1 GENERAL

1.1 CONTRACT DOCUMENTS

A. General fire protection provisions apply to all work performed in Division 21.

B. The Contract Documents are complementary. What is required by anyone, as affects this Division, shall be as binding as if repeated herein.

C. Separation of this Division from other Contract Documents shall not be construed as segregation of the Work.

D. Location of equipment on Drawings is approximate. Plan exact location with respect to site measurements and work of other trades prior to starting work. If measurements differ slightly, modify work. If measurements differ substantially, notify Architect/Engineer and Owner's Authorized Representative prior to fabrication.

E. Make minor changes in equipment connections and equipment locations as directed or required before rough-in without extra cost.

F. For products specified by listing one or more manufacturers, followed by "Similar to" and one manufacture's model number, the following requirements apply:

1. Approval of each listed manufacturer is contingent upon that manufacturer having a product which meets the specification, fits in the available space, and is comparable to the listed model.

2. Electrical requirements, duct requirements, pipe connections, and space requirements indicated on drawings are based on the listed model and may not be suitable for all manufacturers listed. Provide revisions required to accommodate the model actually furnished.

G. For product specified by listing one or more manufacturers, followed by a model number for each manufacturer, the following requirements apply:

1. Provide one of the listed model numbers or an approved substitution.

2. Electrical requirements, duct connections, pipe connections, and space requirements indicated on the Drawings are based on one of the listed models, and may not be suitable for all models listed. Provide revisions required to accommodate the model actually furnished.

1.2 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): A federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority.

B. Owner's Authorized Representative (OAR): Owner's representative with authority to act on Owner's behalf.

C. Architect/Engineer: The design professional leading the design team and can be either an architect or engineer.

D. The words furnish, install and provide are defined as follows:

1. Furnish: To supply and deliver to the project ready for installation and in operable condition.
2. Install: To place in final position, complete, anchored, connected in operable condition.
3. Provide: To furnish and install complete. Includes the supply of specified services.
4. When neither furnish, install or provide is stated, provided is implied.

E. Where content in other sections or divisions is referenced, the words refer and conform are defined as follows:

1. Refer (To): The work referenced in the identified section or division is provided under the referenced section or division. The referenced work is listed for clarity and coordination.
2. Conform (To or With): The work is provided under the section containing the reference and must comply with the requirements of the referenced section or division.

1.3 COORDINATION

A. Check drawings of other trades to avert possible installation conflicts. Should major changes from original drawings be necessary to resolve such conflicts, notify Architect/Engineer and secure written approval and agreement on necessary adjustments before start of work.

B. Architectural drawings govern all other drawings. Consult in detail the door swings, counter heights and similar items affecting work before rough-in.

1.4 SUBMITTALS AND SHOP DRAWINGS

A. See Division 01.

B. Action Submittal Content.

1. Action submittal information not expressly required by the specifications will not be reviewed.
2. Action submittal information shall be provided in sufficient detail to establish conformance with specified requirements. Where submitted literature includes multiple models, features, or options, the specific models, features, or options proposed shall be clearly indicated. Where a brief inspection shows that product data is not complete, the submittal will be rejected without review.
3. Action submittal data shall be clear, concise, legible, and relevant. Where data is not properly organized and contains significant information that is not relevant, the submittal will be rejected without review.
4. Action submittal requirements will be listed in individual specification sections. The following definitions apply.
    a. Materials List: Provide tabular list of materials including specification reference, specification product name, manufacturer, model/part number, and size and/or quantity where appropriate. Do not include supplemental data, except where specifically requested.
    b. Catalog data: Manufacturer’s standard product cut sheet.
    c. Product Data: Detailed data including dimensions, weight, materials of construction, connections, and all other information needed to confirm that the product conforms to all requirements listed in the individual specification section.

d. Performance Data: Capacity, input, output, flow, etc. as required to confirm that the product meets the performance requirements scheduled in the Specifications or on the Drawings.
e. Wiring Diagrams: Power and control wiring diagrams.
f. Shop Drawings: Construction drawings of items manufactured specifically for this project including dimensions, construction details, weights, and additional information to identify the physical features of the system or piece of equipment.
g. Installation Instructions.
h. Special Requirements Listed: Additional requirements indicated in individual specification sections.

1.5 QUALITY ASSURANCE

A. All materials and equipment provided hereunder shall be installed and started in complete conformance with the manufacturer's recommendations.

B. Asbestos products or equipment or materials containing asbestos shall not be used.

1.6 DESIGN REQUIREMENTS

A. Materials and equipment provided hereunder shall be rated for the service conditions of the system to which they are connected including but not limited to temperature, pressure, and humidity.

1.7 CODES AND STANDARDS

A. The Work shall conform to the following Codes and Standards.

1. Codes and Regulations of Governing Authority.

2. Owner's Construction Standards or Guidelines.

B. Contract Documents are intended to comply with referenced Codes and Standards. Any deviation from applicable codes and standards identified in Contract Documents shall be submitted in writing to the Architect/Engineer.

C. Applicable codes and standards shall determine minimum requirements for materials, methods, and labor practices not otherwise stated herein.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

E. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

F. Cover equipment openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during installation, reapply coverings over openings after installation and remove just prior to operation.

G. Replace installed products damaged during construction.

1.9 TEMPORARY SERVICES

A. Provide in accordance with Division 01 as required for completion of work.

B. Maintain existing systems operational. Owner will be responsible to operate and maintain existing equipment during the course of the project. However, any damage to existing equipment resulting directly from work under this Contract shall be repaired by the Contractor at no expense to Owner.

1.10 FIELD CONDITIONS

A. Interruption of Existing Service: Do not interrupt water or sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Owner's Authorized Representative no fewer than five business days in advance of proposed interruption of services.

B. Do not proceed with interruption of services without written permission of Owner's Authorized Representative.

1.11 RECORD DRAWINGS

A. Provide record "as-built" drawings in accordance with Division 1 requirements. Show all deviations from contract drawings and location of underground lines by accurate dimensions from building lines. Show depth of all stub outs and underground lines. Dimension all concealed piping from column grids or building lines. Transfer all information to one hard copy of drawings at completion of project. Alternately, provide electronically using.pdf markup of contract drawings.

1.12 DEMONSTRATION

A. General: After installation is complete, demonstrate to Authority Having Jurisdiction and Owner's Authorized Representative's satisfaction as being complete and operational and entirely in conformance with Contract Documents.

B. Arrange for demonstration with Owner and Authority Having Jurisdiction at least one week in advance of demonstration.

PART 2 PRODUCTS

2.1 PRODUCTS AND MATERIALS

A. All materials employed in permanent construction shall be new, full weight, in first class condition, and suitable for space provided. All similar materials shall be of one manufacturer.

B. Equipment used as the basis of design is scheduled on drawings or designated in product specifications. If Contractor chooses to use equipment that is not the basis of design, Contractor is responsible for all re-design and construction costs associated with variations in arrangement, dimension, or capacity. Such work may include, but is not limited to, changes to facility structure or dimensions and revisions to associated mechanical and electrical systems needed to provide equal system performance and maintainability.

2.2 FIRESTOPPING

A. See Section Division 07

2.3 IDENTIFICATION

A. Provide equipment identification and signage in accordance with NFPA 13.

PART 3 EXECUTION

3.1 ACCESS TO EQUIPMENT AND ACCESSORIES

A. Install equipment with sufficient access for service. Where not conveniently accessible by other means, provide adequately sized access doors for valves, dampers, motors, belts, and all other mechanical equipment requiring access for removal or maintenance. Type, size and exact location of access doors shall be coordinated with Architect prior to work.

B. Provide clearances for maintenance access as indicated on Drawings or as recommended by manufacturer. If access requirements shown on Drawings conflict with manufacturer's recommendations, provide larger clearance of the two.

C. If equipment location shown on Drawings does not allow required access, notify Architect/ Engineer prior to start of work.

D. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to Architect/Engineer for resolution prior to starting work.

E. Provide access doors as required for access to equipment. Doors required for access are not necessarily shown on Drawings. Consult with Architect for direction on placement of required doors not shown on Drawings.

1. Comply with manufacturer's instructions for installation of access doors. Provide all necessary support and supplemental framing for assembly where the access doors are required. Set accurately in position, plumb, level, and flush to adjacent finish surfaces; and secure to support.

3.2 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

A. Coordinate location of piping, sleeves, inserts, hangers and equipment. Locate piping, sleeves, inserts, hangers and equipment clear of windows, doors, openings, lights, electrical outlets, and other services and utilities.

B. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.

C. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.

D. Minor Piping: Small diameter pipe runs from drips and drains and similar minor services are generally not shown but must be provided. Contractor is responsible to provide all such minor piping where needed.

E. Work in Existing Building: Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Owner's Authorized Representative. Locate openings that will least affect structural slabs, columns, ribs or beams. Refer to the

Architect/Engineer for determination of proper design for openings through structural sections and obtain layout approval prior to cutting or drilling into structure. After Architect/Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.

F. Switchgear Drip Protection: Do not install piping above electrical switchgear.

G. Inaccessible Equipment.

1. Where the Owner’s Authorized Representative determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.

2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.3 FIRE PROTECTION SYSTEMS FIRESTOPPING

A. Do not cover firestop installations until the examined by the Authority Having Jurisdiction, if required.

B. Install firestopping in accordance with manufacturer’s recommendations and conditions of product UL listing.

3.4 CLEANING SYSTEMS

A. General: After all equipment and piping is installed, system shall be thoroughly cleaned. Remove all stickers and tags and clean all piping systems prior to painting.

3.5 START UP

A. The Fire Protection Contractor shall be responsible for proper operation of all systems and shall coordinate startup procedures, calibration and system checkout. System operational problems shall be diagnosed and corrected as required for system operation prior to Substantial Completion inspection.

END OF SECTION

SECTION 21 1313

WET-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes pipes, fittings, specialty valves, monitoring and control devices, and other accessories for a complete wet-pipe sprinkler system providing full coverage for areas shown on drawings including elevator shafts and equipment rooms, mechanical rooms, and interstitial spaces.

1.2 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.3 ACTION SUBMITTALS

A. General.

1. Pipe and fittings: Materials List.

2. Specialty Valves, Sprinkler Piping Specialties, Sprinklers, Alarm Devices, Control Panels: Provide catalog data. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Delegated Design.

1. The Contractor shall provide delegated design services in the Contract Documents and in this Section. The Contractor shall be responsible for the design, calculations, submittals, permits, fabrication, transportation and installation of these Delegated Design components. The Contractor is responsible to submit all Delegated Design documents required for approvals by the AHJ.

2. Delegated design shall be performed and documented in accordance with NFPA 13 by a NICET level III fire protection certified technician or persons qualified in accordance with Authority Having Jurisdiction.

3. Comply with requirements of the AHJ over the Work current at the time of submission. The Contractor is responsible to coordinate and submit all material required by the AHJ so review and process of submittals and permits will not adversely affect the construction schedule. Each Delegated Design item requiring review by the AHJ must be provided by the Contractor and all fees and costs associated therewith shall be the Contractor's responsibility at no additional cost to the Owner.

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

a. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

5. Delegated-Design Services Certification: In addition to shop drawings, product data, and other required submittals, submit digitally signed PDF electronic file, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

a. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

C. Delegated Design Submittals:

1. Provide detailed scaled construction drawings showing fire protection piping, heads, valves, and accessories including pipe sizes, locations, elevations, slope of horizontal runs, wall and floor penetrations and connections. Include attachment details and identify system components which are located in areas of the building which are subject to freezing.
   a. Submit preliminary drawings showing exposed piping and sprinkler layout to Architect for approval.
   b. Upon approval by Architect, submit drawings to Authority Having Jurisdiction.
   c. Upon approval by Authority Having Jurisdiction, submit final drawings with approval stamp to Architect.
2. Provide hydraulic calculations per NFPA 13and 14.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations.

C. Fire-hydrant flow test report per NFPA 291.

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

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of 6 spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Installer’s responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering design services. Base calculations on results of fire-hydrant flow test.

B. Contractor shall have five years of experience in design and installation of equipment and systems similar to that specified hereunder. Contractor shall have an office within 100 miles radius of job site which can provide emergency maintenance service.

C. The system designer shall be responsible for verifying site conditions, design requirements, and work being performed by other trades as related to the suppression system design. Design shall accommodate work being performed by other trades. Contractor shall identify areas of the building which will be subject to freezing.

D. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.7 FIELD CONDITIONS

A. Interruption of Existing Sprinkler Service: Refer to requirements in Section 210500 - General Fire Protection Provisions.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system sizing, arrangement, equipment, specialties, accessories, installation, and testing shall comply with NFPA 13 and NFPA 14.

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. Design Requirements:

1. Contractor shall obtain water service test data including static pressure and residual pressure/water flow available at the project site.
2. Sprinkler system design shall be approved by authorities having jurisdiction (AHJ).
3. Margin of Safety for Available Water Flow: 10%.
4. Margin of Safety for Available Water Pressure: 10 psi insert psi.
5. Sprinkler Occupancy Hazard Classifications as indicated on fire zoning plans:
    a. Office and Public Areas: Light Hazard.
6. Provide minimum density as required by NFPA 13.
7. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions according to NFPA 13 and ASCE/SEI 7.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Schedule 40, Galvanized and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 2 and smaller.

C. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

E. Malleable- or Ductile-Iron Unions: UL 860.

F. Cast-Iron Flanges: ASME 16.1, Class 125.

G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

H. Grooved-Joint, Steel-Pipe Appurtenances:

1. Pressure Rating: 175-psig minimum.

2. Galvanized, Painted, or Uncoated Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.

3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Standard: UL 213.

2. Pressure Rating: 175-psig minimum.

3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.

4. Type: Mechanical-tee and -cross fittings.

5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.

6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.

7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Adjustable Drop Nipples:

1. Standard: UL 1474.

2. Pressure Rating: 250-psig minimum.

3. Body Material: Steel pipe with EPDM-rubber O-ring seals.

4. Size: Same as connected piping.

5. Length: Adjustable.

6. Inlet and Outlet: Threaded.

C. Flexible Sprinkler Hose Fittings:

1. Standard: UL 2443.

2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.

3. Pressure Rating: 175-psig minimum.

4. Size: Same as connected piping, for sprinkler.

2.4 SPRINKLERS

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

1. Reliable Automatic Sprinkler Co., Inc. (The).

2. Tyco Fire Products LP.

3. Victaulic Company.

4. Viking Corporation.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

D. Automatic Sprinklers with Heat-Responsive Element:

1. Quick Response Applications: UL 2443.

2. Nonresidential Applications: UL 199.

3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

E. Sprinkler Finishes: Chrome plated bronze and painted.

F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one-piece, flat.

PART 3 EXECUTION

3.1 PREPARATION

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

B. Report test results promptly and in writing.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

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.

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

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

D. Use listed 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.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2-inch and larger end connections.

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

H. Install hangers and supports and seismic restraint for sprinkler system piping according to NFPA 13.

I. Fill sprinkler system piping with water.

J. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2-inch and larger end connections.

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

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

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

1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 SPRINKLER INSTALLATION

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

B. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.5 IDENTIFICATION

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

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

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

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

3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

B. Prepare test and inspection reports.

3.7 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.8 PIPING SCHEDULE

A. Above-grade Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 inches and smaller, shall be the following:

1. Standard-weight, Schedule 40 with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2-inch and larger shall be one of the following:

1. Schedule 10, black-steel pipe with roll-grooved ends: uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.9 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.

2. Rooms with Suspended Ceilings: Recessed sprinklers or Semi-recessed sprinklers.

3. Light hazard fire sprinklers: Quick response.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Recessed or Semi-Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

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SECTION 22 0500

GENERAL PLUMBING PROVISIONS

PART 1 GENERAL

1.1 CONTRACT DOCUMENTS

A. General plumbing provisions apply to all work performed in Division 22.

B. The Contract Documents are complementary. What is required by any one, as affects this Division, shall be as binding as if repeated herein.

C. Separation of this Division from other Contract Documents shall not be construed as segregation of the Work.

D. Location of equipment on Drawings is approximate. Plan exact location with respect to site measurements and work of other trades prior to starting work. If measurements differ slightly, modify work. If measurements differ substantially, notify Architect/Engineer and Owner's Authorized Representative prior to fabrication.

E. Make minor changes in equipment connections and equipment locations as directed or required before rough-in without extra cost.

F. For products specified by listing one or more manufacturers, followed by "Similar to" and one manufacture's model number, the following requirements apply:

1. Approval of each listed manufacturer is contingent upon that manufacturer having a product which meets the specification, fits in the available space, and is comparable to the listed model.

2. Electrical requirements, duct connections, pipe connections, and space requirements indicated on the Drawings are based on the listed model and may not be suitable for all manufacturers listed. Provide revisions required to accommodate the model actually furnished.

G. For product specified by listing one or more manufacturers, followed by a model number for each manufacturer, the following requirements apply:

1. Provide one of the listed model numbers or an approved substitution.

2. Electrical requirements, duct connections, pipe connections, and space requirements indicated on the Drawings are based on one of the listed models and may not be suitable for all models listed. Provide revisions required to accommodate the model actually furnished.

1.2 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): A federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority.

B. Owner's Authorized Representative (OAR): Owner's representative with authority to act on Owner's behalf.

C. Architect/Engineer: The design professional leading the design team and can be either an architect or engineer.

D. The words furnish, install, and provide are defined as follows:

1. Furnish: To supply and deliver to the project ready for installation and in operable condition.
2. Install: To place in final position, complete, anchored, connected in operable condition.
3. Provide: To furnish and install complete. Includes the supply of specified services.
4. When neither furnish, install, or provide is stated, provided is implied.

1.3 COORDINATION

A. Check drawings of other trades to avert possible installation conflicts. Should major changes from original drawings be necessary to resolve such conflicts, notify Architect/Engineer and secure written approval and agreement on necessary adjustments before start of work.

B. Architectural drawings govern all other drawings. Consult in detail the door swings, counter heights and similar items affecting work before rough-in.

C. Coordinate identification systems with other trades. All plumbing and mechanical systems shall use identical piping, valve, and equipment identification and regulatory signage.

1.4 SUBMITTALS AND SHOP DRAWINGS

A. See Division 01.

B. Action Submittal Content.

1. Action submittal information not expressly required by the specifications will not be reviewed.
2. Action submittal information shall be provided in sufficient detail to establish conformance with specified requirements. Where submitted literature includes multiple models, features, or options, the specific models, features, or options proposed shall be clearly indicated. Where a brief inspection shows that product data is not complete, the submittal will be rejected without review.
3. Action submittal data shall be clear, concise, legible, and relevant. Where data is not properly organized and contains significant information that is not relevant, the submittal will be rejected without review.
4. Action submittal requirements will be listed in individual specification sections. The following definitions apply.
    a. Materials List: Provide tabular list of materials including specification reference, specification product name, manufacturer, model/part number, and size and/or quantity where appropriate. Do not include supplemental data, except where specifically requested.
    b. Catalog data: Manufacturer’s standard product cut sheet.
    c. Product Data: Detailed data including dimensions, weight, materials of construction, connections, and all other information needed to confirm that the product conforms to all requirements listed in the individual specification section.

d. Performance Data: Capacity, input, output, flow, etc. as required to confirm that the product meets the performance requirements scheduled in the Specifications or on the Drawings.

e. Wiring Diagrams: Power and control wiring diagrams.

f. Shop Drawings: Construction drawings of items manufactured specifically for this project including dimensions, construction details, weights, and additional information to identify the physical features of the system or piece of equipment.

g. Installation Instructions.

h. Special Requirements Listed: Additional requirements indicated in individual specification sections.

1.5 QUALITY ASSURANCE

A. All materials and equipment provided hereunder shall be installed and started in complete conformance with the manufacturer's recommendations.

B. Asbestos products or equipment or materials containing asbestos shall not be used.

1.6 DESIGN REQUIREMENTS

A. Equipment and systems provided hereunder shall be rated to provide performance specified and scheduled on Drawings at the elevation of the project site.

B. Materials and equipment provided hereunder shall be rated for the service conditions of the system to which they are connected including but not limited to temperature, pressure, and humidity.

1.7 CODES AND STANDARDS

A. The Work shall conform to the following Codes and Standards:

1. Codes and Regulations of Governing Authority.

2. Americans with Disabilities Act (ADA).

B. Contract Documents are intended to comply with referenced Codes and Standards. Any deviation from applicable codes and standards identified in Contract Documents shall be submitted in writing to the Architect/Engineer.

C. Applicable codes and standards shall determine minimum requirements for materials, methods, and labor practices not otherwise stated herein.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

E. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

F. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

G. Replace installed products damaged during construction.

1.9 TEMPORARY SERVICES

A. Provide in accordance with Division 01 as required for completion of work.

B. Maintain existing systems operational. Owner will be responsible to operate and maintain existing equipment during the course of the project. However, any damage to existing equipment resulting directly from work under this Contract shall be repaired by the Contractor at no expense to Owner.

C. All mechanical systems currently operating including plumbing equipment and controls, which serve Owner occupied areas, must be maintained operational during construction. It is the responsibility of the Contractor to provide temporary facilities as required to maintain operation. If any system currently in use must be turned off to perform work, permission must be obtained, and Owner's Authorized Representative notified prior to performing any work.

1.10 FIELD CONDITIONS

A. Interruption of Existing Service: Do not interrupt water, sanitary waste, or storm drain, services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services according to requirements indicated:

1. Notify Owner's Authorized Representative no fewer than five business days in advance of proposed interruption of services.

B. Do not proceed with interruption of services without written permission of Owner's Authorized Representative.

1.11 OPERATIONS AND MAINTENANCE MANUALS

A. Furnish operation and maintenance data for project, as described herein.

B. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF files.

1. Include a directory of all subcontractors and maintenance contractors with names, addresses, and telephone numbers, indicating the area of responsibility for each.

2. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

3. Provide a composite summary table indicating each item of equipment listed in the operations and maintenance manual and its required maintenance and time period. This summary table shall be the first section in the O&M manual.

4. Manual Content: Manuals shall contain complete information for each item of mechanical, electrical or other operating equipment. Include as applicable:

a. Manufacturer's instructions for installation, startup, operation, inspection, and maintenance.

b. Lubrication schedules.

c. Performance capacity.

1) Final approved product submittals for each product included in project.

a) Mark the model actually provided where the literature covers more than one model. Include all submittal data corrected to "as-built" conditions within the manual.

b) Parts list.

d. Maintenance schedules.

e. Maintenance instructions shall indicate routine-type work with step-by-step instructions that should be performed to ensure long life and proper operations. Recommended frequency of performance shall also be included.

5. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

1.12 RECORD DRAWINGS

A. Provide record "as-built" drawings in accordance with Division 1 requirements. Show all deviations from contract drawings and location of underground lines by accurate dimensions from building lines. Show depth of all stub outs and underground lines. Dimension all concealed piping from column grids or building lines. Transfer all information to one hard copy of drawings at completion of project. Alternately, provide electronically using.pdf markup of contract drawings.

PART 2 PRODUCTS

2.1 PRODUCTS AND MATERIALS

A. All materials employed in permanent construction shall be new, full weight, in first class condition, and suitable for space provided. All similar equipment and materials shall be of one manufacturer.

B. Materials and equipment used as the basis of design is scheduled on Drawings or designated in product specifications. If Contractor chooses to use products that are not the basis of design, Contractor is responsible for all re-design and construction costs associated with variations in arrangement, dimension, or capacity. Such work may include, but is not limited to, changes to facility structure or dimensions and revisions to associated mechanical and electrical systems needed to provide equal system performance and maintainability.

C. All potable water systems and components, including but not limited to piping, fittings, valves, equipment, and fixtures, shall meet the requirements listed in Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 ELECTRICAL EQUIPMENT

A. Electrical Disconnect Switch: Electrical disconnect switches specified for plumbing equipment shall conform to OSHA Lock-out/Tag-out requirements.

B. All electrical equipment shall be listed as approved for its application by the Underwriters Laboratory or other testing agency approved by the State of Oregon Electrical and Elevator Board. Approval indicates agency meets testing standard requirements for electrical safety required by Oregon Revised Statutes 479.510 through 479.855 and Oregon Administrative Rules.

C. Enclosure: Provide the following electrical equipment enclosure types unless otherwise noted.

1. NEMA 1: Dry, enclosed locations where the ambient temperature will not be outside of the VFD temperature ratings.

2. NEMA 12: Enclosed mechanical spaces equipped with floor drains where dripping or splashing may occur and where the ambient temperature will not be outside of the VFD temperature ratings.

3. NEMA 3R: Swimming pool mechanical rooms and other mechanical spaces where more sustained water spray is possible.

4. NEMA 3R with Temperature Control: Outdoors or in unconditioned spaces where ambient temperatures will be outside of the VFD temperature ratings.

5. Enclosure will be provided with a ventilation fan and heater capable of maintaining enclosure temperature within the manufacturer's recommended range. Drive and enclosure shall be a single, UL-listed assembly with single point electrical connections.

2.3 FIRESTOPPING

A. Comply with Division 07.

2.4 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Acceptable Manufacturers: J.L. Industries, Karp Associates, Inc., Meadowcraft, Inc., Mifab, Milcor Div.; Inryco, Inc., or Nystrom, Inc.

B. Application: Match access door to wall or roof assembly fire rating.

C. Access Door Assembly: Continuous welded steel construction unless otherwise indicated. Grind exposed welds smooth and flush with adjacent surfaces. Provide anchors and attachments necessary for installation indicated.

1. Frames: 16 gage steel; provide flange type necessary for the installation required.

2. Stainless Steel Frames and Flush Panel Doors: 14 gage stainless steel, No. 4. satin finish; concealed spring hinges or concealed piano hinge set to open 175 degrees.

3. Flush Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees.

4. Lock: Screwdriver-operated cam locks, number required to hold door flush when closed.

5. Ceiling Doors: Recessed door panel depth necessary to finish ceiling insert and install flush to adjacent finish ceiling. Reinforced 18 gage sheet steel face. Provide access sleeves for locking devices. Size: As necessary for efficient access, but not less than 24

by 24 inches. Obtain Architect/Engineer acceptance of manufacturer's standard size units which vary from sizes indicated.

D. Fire Rated Units: Comply with NFPA 80, provide UL listed and labeled units having performance level required with insulated flush panel door, continuous piano hinge and self-closing mechanism for rated assemblies in sizes and configuration required.

1. Vertical Doors: NFPA 252 or UL 10B.

2. Horizontal Doors: ASTM E 119 or UL 263.

E. Shop Applied Coating: Corrosion resistant prime paint compatible with field applied finish specified in Division 09.

F. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 tested according to the following test method:

1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.

2. NFPA 288 for fire-rated access door assemblies installed horizontally.

2.5 SPECIAL TOOLS AND LUBRICANTS

A. Furnish and turn over to Owner, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

PART 3 EXECUTION

3.1 ACCESS TO EQUIPMENT AND ACCESSORIES

A. Install equipment with sufficient access for service. Where not conveniently accessible by other means, provide adequately sized access doors for valves, motors, belts, and all other plumbing equipment requiring access for removal or maintenance. Type, size and exact location of access doors shall be coordinated with Architect/Engineer prior to work.

B. Provide clearances for maintenance access as indicated on Drawings or as recommended by manufacturer. If access requirements shown on Drawings conflict with manufacturer’s recommendations, provide larger clearance of the two.

C. If equipment location shown on Drawings does not allow required access, notify Architect/ Engineer prior to start of work.

D. Apply and install all items in accordance with manufacturer’s written instructions. Refer conflicts between the manufacturer’s instructions and the contract drawings and specifications to Architect/Engineer for resolution prior to starting work.

E. Provide access doors as required for access to plumbing equipment. Doors required for access are not necessarily shown on Drawings. Consult with Architect/Engineer for direction on placement of required doors not shown on Drawings.

1. Comply with manufacturer's instructions for installation of access doors. Provide all necessary support and supplemental framing for assembly where the access doors are required. Set accurately in position, plumb, level, and flush to adjacent finish surfaces; and secure to support.

F. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written

instructions for use.

G. Comply with OSHA regulations.

3.2 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, lights, electrical outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

B. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.

C. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.

D. Minor Piping: Small diameter pipe runs from drips and drains, water cooling, and similar minor services are generally not shown but must be provided. Contractor is responsible to provide all such minor piping where needed to maintain mechanical spaces clean and dry and to allow full equipment function and maintenance.

E. Work in Existing Building: Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Owner’s Authorized Representative. Locate openings that will least affect structural slabs, columns, ribs or beams. Refer to the Architect/Engineer for determination of proper design for openings through structural sections and obtain layout approval prior to cutting or drilling into structure. After Architect/Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.

F. Switchgear Drip Protection: Do not install piping above electrical switchgear.

G. Inaccessible Equipment.

1. Where the Owner’s Authorized Representative determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.

2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.3 PLUMBING SYSTEMS FIRESTOPPING

A. Do not cover firestop installations until they are examined by the Authority Having Jurisdiction, if required.

B. Install firestopping in accordance with manufacturer’s recommendations and conditions of product UL listing.

3.4 LUBRICATION

A. Lubricate all devices requiring lubrication prior to initial operation. Field check all devices for proper lubrication.

B. Equip all devices with required lubrication fittings or devices.

C. All lubrication points shall be accessible without disassembling equipment, except to remove access panels.

3.5 CLEANING SYSTEMS

A. General: After all equipment and pipes are installed, system shall be thoroughly cleaned. Remove all stickers and tags from equipment or fixtures. Clean all piping systems prior to installation of insulation or painting.

3.6 START UP

A. The Plumbing Contractor shall be responsible for proper operation of all systems and shall coordinate startup procedures, calibration and system checkout. System operational problems shall be diagnosed and corrected as required for system operation prior to Substantial Completion inspection.

B. Start equipment in accordance with manufacturer's recommendations and under manufacturer's supervision where required. Ensure that associated strainers, electrical overloads, and other devices intended to protect the equipment are installed and functional prior to startup.

C. Verify that piping has been flushed and cleaned prior to startup.

3.7 DEMONSTRATION

A. General: After installation is complete, demonstrate to Architect/Engineer and Owner's Authorized Representative satisfaction as being complete and operational and entirely in conformance with Contract Documents.

B. Arrange for demonstration with Owner's Authorized Representative, Architect/Engineer, required factory technicians, and installer at least one week in advance of demonstration.

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SECTION 22 0523

VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes valves for plumbing service.

1.2 DEFINITIONS

A. CWP: Cold Working Pressure.

B. EPDM: Ethylene propylene copolymer rubber.

1.3 ACTION SUBMITTALS

A. Provide catalog data for each type of valve.

B. Provide certification that products comply with NSF 61.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

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

B. Use the following precautions during storage:

1. Maintain valve end protection.

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

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

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.

2. ASME B16.5 for flanges on steel valves.

3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

4. ASME B31.9 for building service piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. 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.

E. NSF Compliance: NSF 372 for valve materials for potable-water service.

F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valves in Insulated Piping:

1. Include 2-inch stem extensions.

2. Ball Valves:

a. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.

b. Memory stops shall be fully adjustable after insulation is applied.

2.2 BALL VALVES

A. NPS 3 and Smaller:

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

a. Apollo Valves/Conbraco Industries, Inc.

b. Hammond Valve.

c. Jenkins Valves; Crane Energy Flow Solutions.

d. NIBCO INC.

e. Stockham; Crane Energy Flow Solutions.

2. Two-Piece Bronze Ball Valves with Full Port and Bronze or Brass Trim:

a. Standard: MSS SP-110.

b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.

d. Body Design: Two piece.

e. Body Material: Bronze.

f. Ends: Threaded.

g. Seats: PTFE.

h. Stem: Bronze.

i. Ball: Chrome-plated brass or Stainless-steel.

j. Port: Full.

k. Packing: Adjustable.

2.3 CHECK VALVES

A. NPS 2 and Smaller:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Apollo Valves/Conbraco Industries, Inc.
    b. Crane; Crane Energy Flow Solutions.
    c. Hammond Valve.
    d. Jenkins Valves; Crane Energy Flow Solutions.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Stockham; Crane Energy Flow Solutions.
2. Class 125, Bronze Swing Check Valves with Bronze Disc.
    a. Standard: MSS SP-139, Type 3.
    b. CWP Rating: 200 psig.
    c. Body Design: Horizontal flow.
    d. Body Material: ASTM B 584, bronze.
    e. Ends: Threaded.
    f. Disc: Bronze. Renewable seats and disc.

2.4 DRAIN VALVES

A. NPS 2 and Smaller:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Apollo Valves/Conbraco Industries, Inc.
    b. Hammond Valve.
    c. Jenkins Valves; Crane Energy Flow Solutions.
    d. NIBCO INC.
    e. Stockham; Crane Energy Flow Solutions.
2. Two-Piece Bronze Ball Valves with Full Port and Bronze or Brass Trim:
    a. Standard: MSS SP-110.
    b. SWP Rating: 150 psig.
    c. CWP Rating: 600 psig.
    d. Body Design: Two piece.
    e. Body Material: Bronze.
    f. Inlet: Threaded.
    g. Outlet: Threaded with 3/4-inch male hose threaded adapter.
    h. Seats: PTFE.

i. Stem: Stainless-steel.

j. Ball: Chrome-plated brass or Stainless-steel.

k. Port: Full.

l. Packing: Adjustable.

m. Cap: Brass with EPDM gasket and brass chain.

PART 3 EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges to isolate each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

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

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

D. Install valves in position to allow full stem movement, with handle swing in direction of flow.

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

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.

3. Install check valves a minimum of five pipe diameters away from changes of direction, pumps, or equipment that can generate turbulent flow in piping.

3.3 ADJUSTING

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

3.4 GENERAL VALVE APPLICATIONS.

A. Provide valves for isolation of services as shown on Drawings and at the following locations:

1. Where piping penetrates the building envelope.

2. Where piping enters the building from a tunnel.
3. At branch connections from piping risers at each floor.
4. Major branches and branches to remote equipment or fixtures for all supply and return systems.
5. As required to individually isolate all equipment and maintainable devices including automatic air vents and control valves.
6. To individually isolate building systems by section.
7. Where piping penetrates mechanical room walls. Locate valve inside mechanical room.
8. Branch connections for utility systems including piping in utility tunnels.
9. Point of entry into individual suites, classroom, or laboratories for all plumbing piping systems, gas, compressed air, Nitrogen, vacuum, water, etc.

B. Provide valves where recommended by equipment manufacturer's installation instructions.

C. Drain Valves:

1. Provide drain down valves at the low point in each zone, area of service, or floor level.
2. Provide drain down valves to drain equipment.

D. Gauge Stop Valves:

1. Size to match gauge connection.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Shutoff Service:

1. Pipe NPS 3 and Smaller: Two-Piece Bronze Ball Valves with Full Port and Bronze or Brass Trim.

B. Check Valve Service:

1. NPS 2 and Smaller: Class 125, Bronze Swing Check Valves with Bronze Disc.

C. Drain, Gauge Stop, Strainer Blowdown.

1. Two-Piece Bronze Drain Valves with Full Port and Bronze or Brass Trim.

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SECTION 22 0529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Design and installation of hangers and supports for plumbing piping and equipment provided in Division 22. Exceptions include equipment whose structural attachment has been designed by the design team structural engineer.

1.2 DEFINITIONS

A. ASCE: American Society of Civil Engineers.

B. ASME: American Society of Mechanical Engineers.

C. ASTM: American Society for Testing and Materials.

D. MFMA: Metal Framing Manufacturers Association.

E. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.3 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. Supports for multiple pipes, including pipe stands, shall be capable of supporting combined weight of supported systems, system contents, and test water.

2. Equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in conformance with Section 220500 - General Plumbing Provisions. Submittal requirements indicated by column number designation as follows:

1. Materials List.

2. Catalog Data.

3. Detailed Data.

4. Performance Data.

5. Wiring Diagrams.

6. Shop Drawings.

7. Installation Instructions.

8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Pipe Hangers and Supports		X						
Thermal Hanger Shield Inserts		X						

B. Shop Drawings:

1. Plans showing type and location of supports and assemblies. Provide full or half size copies of piping plans from the Contract Documents or coordination drawings, showing location and type of each support component to be installed. Drawings shall consist of mechanically reproduced copies of the Contract Documents, or new drawings custom drafted specifically for the Work of this Project. Each drawing shall be printed on a single sheet.

2. Detail fabrication and assemblies for support assemblies including metal framing systems, equipment supports, trapeze hangers, pipe support stands to comply with performance requirements and design criteria. Assemblies may be pre-engineered or custom designed for the application.

3. Detail anchorages and attachments to structure. Where walls, floors, slabs or supplementary steel work are used for support, details of acceptable attachment methods must be included and approved before the condition is accepted for installation. Drawings must include spacing and static loads at all attachment and support points.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper- or epoxy-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

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

a. B-line, an Eaton business.

b. Thomas & Betts Corporation; A Member of the ABB Group.

c. Unistrut; Part of Atkore International.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
7. Metallic Coating: Electroplated zinc, In-line, hot galvanized, or Mechanically-deposited zinc.

2.3 INSULATION INSERTS

A. General: Insulation insert for use with MSS Type 40 protection saddle.

B. Insulation-Insert Materials for Cold Piping:

1. Cellular Glass:

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

1) Foamglas.

b. ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

2. Phenolic Foam:

a. ASTM C1126 Type III phenolic foam with factory laminated ASJ.

1) 1-1/2” to 2-1/2” pipe size: 32 psi at load point.

2) 3” to 6” pipe size: 85 psi at load point.

3) 8” to 12” pipe size: 135 psi at load point.

C. Insulation-Insert Material for Hot Piping, Fluid Temperature of 200 deg F and less:

1. Calcium Silicate:

a. Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

2. Phenolic Foam:

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

1) Insultherm.

2) Johns Manville.

3) Resolco, Inc.

b. ASTM C1126 Type III phenolic foam with factory laminated ASJ.

1) Maximum Temperature: 220 deg F.

2) Maximum Load:

a) 1-1/2” to 2-1/2” pipe size: 32 psi at load point.

b) 3” to 6” pipe size: 85 psi at load point.

c) 8” to 12” pipe size: 135 psi at load point.

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

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

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

2.4 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, zinc-coated steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 PIPE POSITIONING SYSTEMS

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

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Non-staining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT 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 Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

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

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

E. 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.

F. 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.

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

H. 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.

I. Insulated Piping:

1. Piping Operating Above Ambient Air Temperature:

a. Steel Piping 4-inches and Larger: Provide MSS Type 39 Protective Saddle.

b. All Other Piping: Provide Insulation Insert with MSS Type 40 protection shield.

2. Piping Operating Below Ambient Air Temperature:

a. Provide Insulation Insert with MSS Type 40 protection shield.

3. 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.

4. Insulation Inserts: Same thickness as piping insulation.

3.2 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.

3.3 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal shall conform with requirements in Division 09.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.4 HANGER SPACING

PLUMBING PIPING SPACING TABLE	MAXIMUM HORIZONTAL SPAN	MAXIMUM VERTICAL SPACING
CARBON STEEL AND STAINLESS-STEEL		
3/4 INCH AND SMALLER	10 FEET	BASE AND EACH FLOOR, NOT TO EXCEED 15 FEET
1 INCH AND LARGER	12 FEET	
STEEL PIPING FOR GAS		
1/2 INCH	6 FEET	6 FEET
3/4 INCH AND 1 INCH	8 FEET	8 FEET
1-1/4 INCHES AND LARGER	10 FEET	EVERY FLOOR LEVEL
COPPER TUBING		
1-1/2 INCH AND SMALLER	6 FEET	EACH FLOOR, NOT TO EXCEED 10 FEET
2 INCH AND LARGER	10 FEET	
PVC		
ALL SIZES	4 FEET	BASE AND EACH FLOOR, PLUS MID-STORY GUIDES
CPVC LESS THAN 130 DEG F		
1 INCH AND SMALLER	3 FEET	BASE AND EACH FLOOR, PLUS MID-STORY GUIDES
1-1/4-INCH AND LARGER	4 FEET	
PEX		
1 INCH AND SMALLER	32 INCHES	BASE AND EACH FLOOR, PLUS MID-STORY GUIDES
1-1/4 INCHES AND LARGER	4 FEET	
POLYPROPYLENE		
1 INCH AND SMALLER	32 INCHES	BASE AND EACH FLOOR, PLUS MID-STORY GUIDES
1-1/4 INCHES AND LARGER	4 FEET	
CAST IRON		
ALL SIZES	EVERY OTHER JOINT, UNLESS OVER 4 FEET, THEN SUPPORT EACH JOINT.	BASE AND EACH FLOOR, NOT TO EXCEED 15 FEET

3.5 ROD SIZES

A. Select rod diameter to not exceed the maximum safe load listed in Table 2 of MSS SP-58-2009 and to not be smaller than the hanger rod diameters listed in OPSC Table 313.6.

3.6 HANGER AND SUPPORT SCHEDULE

A. Single Pipe, Hung and Uninsulated.

1. NPS ½ to NPS 3: Adjustable Steel Band Hanger, MSS Type 7.
2. NPS 4 and Larger: Steel Clevis, MSS Type 1.

B. Single Pipe, Hung and Insulated.

1. Operating Temperature Less Than Ambient: Steel Clevis, MSS Type 1.
2. Operating Temperature Greater Than Ambient.
    a. NPS ½ to NPS2: Steel Clevis, MSS Type 1.
    b. NPS 3 and Larger: Adjustable Roller Hanger: Type 43.

C. Multiple Pipe Trapeze or Pipe Rack: Trapeze Hanger, MSS Type 59.

1. Uninsulated Piping: Steel Strap.
2. Insulated Piping: Adjustable Roller, MSS Type 43.

D. Single Pipe Floor Support: Adjustable Pipe Support Saddle: MSS Type 38.

E. Vertical Piping: For riser support and restraint conform with Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

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

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

H. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

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

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

K. To eliminate the need for seismic restraint, for piping installation where the distance from the top of the pipe to the structure is 12 inches or less for the entire run, select hanger-rod and building attachments to allow pipe movement without stress on hangers and attachments.

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

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

M. 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.

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

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

O. 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.

P. 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.

Q. 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.

R. Vertical-Piping Supports: Unless otherwise required, 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.

S. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications.

T. Comply with MFMA-103 for metal framing system selections and applications.

U. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

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

END OF SECTION

SECTION 22 0553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe labels.
2. Valve tags.
3. Ceiling 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. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

A. Coordinate with Divisions 21 and 23. Match manufacturer, type, and style of identification used.

PART 2 PRODUCTS

2.1 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

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

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.2 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass or Aluminum, 0.025-inch minimum thickness and having predrilled or stamped holes for attachment hardware.

2. Minimum Tag Size: 1-1/2 inches, round.

3. Fasteners: Brass wire-link chain or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.3 CEILING LABELS

A. Self-Adhesive Ceiling Labels: Printed clear plastic with contact-type, permanent-adhesive backing.

1. Minimum Letter Size: 1/2-inch minimum height.

2. Letter Color: Black.

3. Label Content: Equipment identification label and number.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION 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. Label inside of access doors with equipment name or general purpose of equipment behind access door with stenciled sign or markers.

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

D. Ceiling Grids and Access Openings: Label ceiling grid and wall/ceiling access doors to indicate key access points for equipment, valves, control devices and other components requiring quick access or routine maintenance. Provide ceiling labels, except were Owner has established a standard identification label. Place label on ceiling metal grid and not on removable tiles.

3.3 PIPE LABEL INSTALLATION

A. 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. Near each valve and control device.

2. Near each flange.

3. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

4. Within 3 feet of penetrations through walls, floors, ceilings, inaccessible enclosures, valves, equipment connections, and branch connections.
5. At access doors, manholes, and similar access points that permit view of concealed piping.
6. Near major equipment items and other points of origination and termination.
7. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule: Letter and background color in accordance with ASME A13.1.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch valve tag numbers.

END OF SECTION

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SECTION 22 0719

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes insulating plumbing piping.

1.2 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in conformance with Section 220500 - General Plumbing Provisions. Submittal requirements indicated by column number designation as follows:

1. Catalog Data.

2. For each type of insulation product listed, provide thermal conductivity and water-vapor permeance.

1.3 QUALITY ASSURANCE

A. Insulation materials and accessories shall be installed in a professional manner by skilled and experienced workers who specialize in commercial insulation work.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.4 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields. Conform with requirements in Section 220529 - Hangers and Supports for Plumbing Piping and Equipment.

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

1.5 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

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

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

D. Insulation jacket material shall be paintable where painting of the insulation jacket is specified.

E. Mineral-Fiber, Preformed Pipe Insulation:

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

a. Johns Manville; a Berkshire Hathaway company.

b. Knauf Insulation.

c. Manson Insulation Inc.

d. Owens-Corning.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180 deg F.

3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

4. Color: White.

2.4 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.5 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

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

a. Johns Manville; a Berkshire Hathaway company.

b. P.I.C. Plastics, Inc.

c. Proto Corporation.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: White.

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

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.

B. 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.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

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.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
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 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install 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.

C. Install insulation with longitudinal seams at top and bottom of horizontal runs.

D. Install multiple layers of insulation with longitudinal and end seams staggered.

E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. 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.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. 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 on-center.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches on-center.

a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. 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.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Conform with requirements in Section 220500 - General Plumbing Provisions for firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at the following:

1. Valves.
2. Flanges and unions requiring access to allow equipment service.
3. Mechanical couplings requiring access to allow equipment service.

E. 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 at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches on-center.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 PIPING INSULATION THICKNESS

A. General.

1. For piping smaller than 1-1/2 inches and located in partitions within conditioned spaces, reduction of thickness by 1-inch permitted to a thickness not less than 1-inch.

B. Mineral Fiber Insulation

FIBERGLASS					
FLUID NORMAL OPERATING TEMPERATURE (deg F)	NOMINAL PIPE OR TUBE SIZE (inches)				
	<1	1 to < 1.5	1.5 to < 4	4 to < 8	< 8
>350	5	5	5	5	5
251-350	3.5	4.5	4.5	4.5	4.5
201-250	2.5	2.5	2.5	3	3
141-200	1.5	1.5	2	2	2
105-140	1	1	1.5	1.5	1.5
40-60	0.5	0.5	1	1	1
<40	0.5	1	1	1	1.5

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. For all systems with an operating temperature that may be below ambient conditions, a vapor barrier must be maintained.

C. For piping smaller than 1-1/2 inches and located in partitions within conditioned spaces, reduction of thickness by 1-inch is permitted to a thickness not less than 1-inch.

D. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Base insulating thickness on operating temperature unless thickness is specifically listed in section below.

B. Potable Cold-Water Piping: Normal operating temperature 50 deg F.

1. Mineral-Fiber, Preformed Pipe Insulation, Type I.

C. Potable Hot Water and Hot Water Recirculation Piping: Normal operating temperature range 105 deg F to 140 deg F.

1. Mineral-Fiber, Preformed Pipe Insulation, Type I.

D. Stormwater and Overflow:

1. Mineral Fiber, 1-inch.

E. Roof Drain and Overflow Drain Bodies:

1. Mineral Fiber, 1-inch.

F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 deg F:

1. Mineral Fiber: 1-inch.

G. Hot Service Drains:

1. Mineral Fiber: 1-inch.

H. Hot Service Vents:

1. Mineral Fiber: 1-inch.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2-inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-inch thick.

C. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. PVC: 20 mils thick.

END OF SECTION

SECTION 22 1000

PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes pipe, fittings, and joining methods for plumbing piping.

1.2 PERFORMANCE REQUIREMENTS

A. All potable water plumbing piping, equipment, fittings, and accessories shall be capable of withstanding a maximum pressure of 125 psi and a maximum temperature of 140 deg F. Exceptions would include specific items of equipment where a lower operating pressure is specified.

B. Sanitary waste and vent and storm drain, and force-main components and installation shall be capable of withstanding the following minimum working pressures unless otherwise indicated:

1. Soil, Waste and Vent: 10 ft WC.

1.3 DEFINITIONS

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

B. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Provide materials list for pipe and fittings.

B. Provide catalog data for dielectric fittings.

1.5 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting report.

B. Field quality-control reports.

C. Certificates: Brazing.

1.6 QUALITY ASSURANCE

A. Installer Qualifications.

1. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.

B. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

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

D. ASME Compliance:

1. Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.

2. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

1.7 FIELD CONDITIONS

A. Interruption of Existing Plumbing Services: Refer to requirements in Section 220500 - General Plumbing Provisions.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Plastic piping components shall be marked with "NSF-pw."

B. Comply with NSF Standards 372.

C. Piping materials shall bear label, stamp, or other markings of specified testing agency.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88 Type L.

B. Annealed-Temper Copper Tube: ASTM B88 Type L.

C. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

D. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

E. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

F. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.

G. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

H. Copper Flanges: ASME B16.24, Class 150 or 300, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

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

I. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

J. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

K. Wrought Copper Unions: ASME B16.22.

L. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

M. Copper-Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.

1. Description: Tee formed in copper tube in accordance with ASTM F2014.

2.3 PEX TUBE AND FITTINGS

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

the following:

1. Rehau.
2. Uponor.
3. Viega LLC.
4. Watts Radiant; a Watts Water Technologies company.

B. Tube Material: PEX plastic according to ASTM F 876 and ASTM F 877.

C. Fittings: ASTM F1960, cold expansion fittings and reinforcing rings.

D. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F876; with plastic or corrosion-resistant-metal valve for each outlet.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Plain Finish Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Standards: ASTM C 1277 and CISPI 310.
2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A53/A53M, Type E, Grade B, Standard Weight. Include square-cut-grooved or threaded ends matching joining method.

B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12, threaded.

C. Steel Pipe Pressure Fittings:

1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16. 39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16. 4, Class 125, standard pattern.

D. Cast-Iron Flanges: ASME B16. 1, Class 125.

1. Flange Gasket Materials: ASME B16. 21, full-face, flat, nonmetallic, asbestos-free, 1/8 inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18. 2. 1, carbon steel unless otherwise indicated.

2.6 PVC PIPE AND FITTINGS

A. Solid-Wall Schedule 40 PVC Pipe:

1. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
2. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
    a. Same size as pipes to be joined.
    b. Pressure rating at least equal to pipes to be joined.
    c. End connections compatible with pipes to be joined.
2. Unshielded, Non-pressure Transition Couplings:
    a. Standard: ASTM C 1173.
    b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    c. End Connections: Same size as and compatible with pipes to be joined.
    d. Sleeve Materials:
        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
        2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
        3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
3. Shielded, Non-pressure Transition Couplings:
    a. Standard: ASTM C 1460.
    b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
    c. End Connections: Same size as and compatible with pipes to be joined.
4. Pressure Transition Couplings:
    a. Standard: AWWA C219.
    b. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
    c. Center-Sleeve Material: Manufacturer's standard.
    d. Gasket Material: Natural or synthetic rubber.
    e. Metal Component Finish: Corrosion-resistant coating or material.

2.8 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 B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer according to ASTM F656.

G. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.9 DIELECTRIC FITTINGS

A. Dielectric Unions:

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

a. Watts; a Watts Water Technologies company.

b. Wilkins.

2. Standard: ASSE 1079.

3. Pressure Rating: 125 psig minimum at 180 deg F.

4. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of plumbing 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 by Engineer.

B. Install piping in concealed locations and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

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

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

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 complete systems drainage. Provide drains at system low points.

J. Install copper tubing according to CDA's "Copper Tube Handbook."

K. Install shutoff valve immediately upstream of each dielectric fitting.

L. Install domestic water piping level and plumb.

M. 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.

N. Install PEX tubing with loop at each change of direction of more than 90 degrees, with minimum bending radius as recommended by manufacturer.

O. Install aboveground PVC piping according to ASTM D 2665.

P. Install steel piping according to applicable plumbing code.

Q. 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.".

R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

S. 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. Do not reduce size of waste piping in direction of flow.

T. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Sanitary Waste: 2 percent downward in direction of flow for piping 3 NPS and smaller.

2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

U. Waste, Vent, and Storm Drain Plumbing Specialties:

1. Install cleanouts at grade where shown on drawings. Provide a cleanout to exterior grade wherever sanitary or storm drain piping leaves the building.

2. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.

V. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

W. Install sleeves for piping penetrations of walls, ceilings, and floors.

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

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
3. Do not use pipe sections that have cracked or open welds.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

F. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

G. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for service. Join flanges with gasket and bolts according to ASME B31.9.

I. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. PVC Piping: Join according to ASTM D2855 and ASTM D2665 appendixes.

J. Joints for PEX Tubing, ASTM: Join according to ASTM F1960 for cold expansion fittings and reinforcing rings.

K. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 INSTALLATION OF SPECIALTY FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of dissimilar piping or piping with small differences in outside diameters.
2. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.
3. In Waste Drainage Piping: Non-pressure transition couplings. Shielded below grade. Unshielded above grade.

3.4 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings, nipples, or unions.

C. Install dielectric fittings in accessible location.

D. Install unions only in accessible locations.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Conform with requirements for hangers, supports, and anchor devices in Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

B. Support vertical piping and tubing at base and at each floor.

3.6 CONNECTIONS

A. Connect piping in sizes indicated, but not smaller than required by plumbing code.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve.

E. Connect to equipment, fixtures, and specialties with pipe sizes indicated but not smaller than the size of the equipment, fixture, or specialty connection. Use flanges instead of unions on equipment NPS 2-1/2 and larger and adjacent to flanged valves.

3.7 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. 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.

3.8 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. Perform the following tests and inspections. Notify the Owner's Authorized Representative a minimum of 5 business days prior to performing tests. Tests must be witnessed and acknowledged in writing by the Owner's Authorized Representative:

1. Domestic and Non-Potable Water 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. Domestic and Non-Potable Water 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 water 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. Visually inspect each joint during the test period. 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.

3. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

a. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

1) If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

b. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

1) Expose work that was covered or concealed before it was tested.

c. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

1) Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.

2) From 15 minutes before inspection starts to completion of inspection, water level must not drop.

3) Inspect joints for leaks.

d. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections, and prove they are gastight and watertight.

1) Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 in wg.

2) Use U-tube or manometer inserted in trap of water closet to measure this pressure.

3) Air pressure must remain constant without introducing additional air throughout period of inspection.

4) Inspect plumbing fixture connections for gas and water leaks.

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 required corrective action.

D. Plumbing piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports and have them signed by authorities having jurisdiction.

3.9 CLEANING

A. Notify the Owner's Authorized Representative a minimum of 5 business days prior to disinfection of the plumbing system. The Owner's Authorized Representative shall witness the disinfection process.

B. Clean interior of plumbing piping systems. Remove dirt and debris as work progresses.

C. Protect sanitary waste and vent piping during construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

D. Place plugs in ends of uncompleted piping at end of day and when work stops.

E. Repair damage to adjacent materials caused by piping installation.

F. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

G. 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.

H. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

3.10 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. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:
1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed joints.

F. Non-potable water trap primer piping, for all drain types other than hot drains, shall be one of the following:
1. Soft copper tube, ASTM B88, Type L wrought-copper, solder-joint fittings; and soldered joints.
2. PEX tube. Fittings for PEX tube shall be provided by the same manufacturer as the tubing, and shall be one of the following:
    a. ASTM F1807, metal insert and copper crimp rings.
    b. ASTM F1960, cold expansion fittings and reinforcing rings.

c. ASSE 1061, push-fit fittings.

G. All sanitary waste, storm water, and underground vent piping shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
2. Solid-wall Schedule 40 PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Non-pressure transition couplings. Shielded for underground installation, unshielded for aboveground installation.

H. Aboveground, vent piping shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
2. Galvanized-steel pipe, drainage fittings, and threaded joints.
3. Hard copper tube, Type DWV; copper drainage fittings; and soldered joints.
4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, Non-pressure transition couplings.

END OF SECTION

SECTION 22 1119

DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in conformance with Section 22 0500 - General Plumbing Provisions. Submittal requirements indicated by column number designation as follows:

1. Materials List.
2. Catalog Data.
3. Product Data.
4. Performance Data.
5. Wiring Diagrams.
6. Shop Drawings.
7. Installation Instructions.
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Items this Section		X						

1.2 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.3 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 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves - Occupied Spaces (TMV-x):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Acorn Engineering Company.
    b. Lawler Manufacturing Company, Inc.

c. Leonard Valve Company.

d. Powers.

e. Symmons Industries, Inc.

f. Zurn Industries, LLC.

2. Standard: ASSE 1017.

3. Pressure Rating: 125 psig minimum unless otherwise indicated.

4. Type: Cabinet-type, thermostatically controlled, water mixing valve.

5. Material: Bronze body with corrosion-resistant interior components.

6. Connections: Threaded union inlets and outlet.

7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

8. Tempered-Water Setting: 120°F, 125°F, 130°F, or as shown on drawings.

9. Valve Finish: Chrome-plated.

10. Piping Finish: Chrome-plated.

11. Cabinet: Factory fabricated, stainless-steel, for recessed or surface mounting and with hinged, stainless-steel door.

B. Individual-Fixture, Water Tempering Valves:

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

a. Acorn Engineering Company.

b. Apollo Valves; Conbraco Industries, Inc.

c. Lawler Manufacturing Company, Inc.

d. Leonard Valve Company.

e. Powers.

f. Watts; a Watts Water Technologies company.

g. Zurn Industries, LLC.

2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.

3. Pressure Rating: 125 psig minimum unless otherwise indicated.

4. Body: Bronze body with corrosion-resistant interior components.

5. Temperature Control: Adjustable.

6. Inlets and Outlet: Threaded.

7. Finish: Rough or chrome-plated bronze.

2.4 WALL HYDRANTS

A. Conditioned Space Wall Hydrants - Concealed (HB-1):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Watts; a Watts Water Technologies company.
    e. Woodford Manufacturing Company.
    f. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet:
    a. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052. Automatic draining with hose attached.
    b. Garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze or chrome plated.
9. Nozzle and Wall-Plate Finish: Polished nickel bronze or chrome-plated.
10. Operating Key(s): One with each wall hydrant.

2.5 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 seal and brass chain.

2.6 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Precision Plumbing Products, Inc.
    e. Watts; a Watts Water Technologies company.
    f. Zurn Industries, LLC.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston, factory pressurized and sealed.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

B. Install water-hammer arresters in water piping according to PDI-WH 201.

3.2 ADJUSTING

A. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

SECTION 22 1319

SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.1 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in conformance with Section 22 0500 - General Plumbing Provisions. Submittal requirements indicated by column number designation as follows:

1. Materials List.
2. Catalog Data.
3. Product Data.
4. Performance Data.
5. Wiring Diagrams.
6. Shop Drawings.
7. Installation Instructions.
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products in this Section		X						

1.2 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.3 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. 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 FLOOR DRAINS

A. Floor Drain General Requirements:

1. Strainer Free Area: A minimum of one and one-half times the cross-sectional area of the connected drain or sanitary waste piping.
    a. 2-inch Outlet Floor Drain: 5 square inches minimum free area.
    b. 3-inch Outlet Floor Drain: 7 square inches minimum free area.
    c. 4-inch Outlet Floor Drain: 12-1/2 square inches minimum free area.

d. 6-inch Outlet Floor Drain: 28 square inches minimum free area.

2. Top Shape: Unless otherwise noted, top shapes shall be as follows:

a. Areas with Tile Floors: Square.

b. All Other Floor Finishes: Round.

B. Cast-Iron Floor Drains (FD-1):

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

a. Jay R. Smith Mfg. Co; a division of Morris Group International.

b. Josam Company.

c. MIFAB, Inc.

d. Sioux Chief Manufacturing Company, Inc.

e. WATTS.

f. Zurn Industries, LLC.

2. Standard: ASME A112.6.3.

3. Pattern: Floor drain with adjustable strainer.

4. Body Material: Gray iron.

5. Seepage Flange: Required.

6. Anchor Flange: Required.

7. Clamping Device: Required.

8. Outlet: Bottom.

9. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.

10. Sediment Bucket: Not required.

11. Top or Strainer Material: Nickel bronze.

12. Top of Body and Strainer Finish: Nickel bronze.

13. Top Loading Classification: Light Duty.

14. Trap Material: Cast iron.

15. Trap Pattern: Standard P-trap.

16. Trap Features: Trap-seal primer valve drain connection.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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

a. Acorn Engineering Company.

b. Thaler Metal Industries Ltd.

c. Zurn Industries, LLC.

2. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch-thick, lead flashing collar and skirt extending at least 10 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

a. Open-Top Vent Cap: Without cap.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Seal penetrations through fire-rated assemblies. Conform with requirements in Section 220500 - General Plumbing Provisions.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Trap-Seal Primer Fittings:

1. Description: Material to match floor drain or floor sink p-trap, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.

2. Size: Same as floor drain or floor sink outlet with NPS 1/2 side inlet.

B. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

2. Size: As required for close fit to riser or stack piping.

C. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2. Size: Same as connected stack vent or vent stack.

D. Expansion Joints:

1. Standard: ASME A112.6.4.

2. Body: Cast iron with bronze sleeve, packing, and gland.

3. End Connections: Matching connected piping.

4. Size: Same as connected soil, waste, or vent piping.

PART 3 EXECUTION

3.1 INSTALLATION

A. 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 and floor sink 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, floor sinks, and trench drains connected to sanitary building drain, unless otherwise indicated.

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 horizontal change in direction of piping greater than 135 degrees.

3. Locate at minimum intervals of 50 feet for piping NPS 3 and smaller and 100 feet for larger piping.

4. Locate at base of each vertical soil and waste stack or vertical storm piping conductor.

C. Install roof flashing assemblies or flashing fittings on sanitary stack vents and vent stacks that extend through roof.

D. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

E. Install trap-seal primer fittings on inlet to floor drains and floor sinks and floor sinks and trench drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if the trap or drain fixture has a trap-seal primer connection.

2. Size: Same as floor drain inlet.

F. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

G. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

H. Install wood-blocking reinforcement for wall-mounting-type specialties.

I. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, refer to Division 07.

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Tests and Inspections:

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.

3.3 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

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SECTION 22 4200

COMMERCIAL PLUMBING FIXTURES

PART 1 GENERAL

1.1 DEFINITIONS

A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.

B. FRP: Fiberglass-reinforced plastic.

C. GPF: Gallons per flush.

D. GPM: Gallons per minute.

E. MaP: Maximum performance test score per ASME A112.19.2/CSA B45.1.

F. PDI: Plumbing and Drainage Institute.

1.2 STANDARDS

A. ASTM D4551 Standard for PVC (Plasticized Polyvinyl Chloride) sheets.

B. ASTM C478, Standard for CPE (Chlorinated Polyethylene) sheets.

C. ASTM B152, Standard for Sheet Copper.

D. ASME A112.18.1 Standard for faucets and fixture fitting.

E. ASME A112.3.1 Standard for Floor Drains.

1.3 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 22 05 00 - General Plumbing Provisions. Submittal requirements indicated by column number designation as follows:

1. Materials List.
2. Catalog Data.
3. Product Data.
4. Performance Data.
5. Wiring Diagrams.
6. Shop Drawings.
7. Installation Instructions.
8. Special Requirement listed herein

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products in this Section		X						

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves, faucets, and electronic sensors to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

2. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed, but no fewer than one of each type.

3. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed, but no fewer than one of each type.

4. Shower Valve Washers and O-Rings: Equal to 10 percent of amount of each type and size installed, but no fewer than one of each type.

1.6 QUALITY ASSURANCE

A. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Materials provided shall be new unless otherwise noted.

B. Vitreous china fixtures shall be non-absorbent and fully vitrified throughout, white in color unless otherwise noted.

C. Enameled ware shall be high-quality cast iron of uniform thickness and density with enamel coating of uniform depth, fully bonded to the base metal without chips or flaws, crazing, or cracks. Enamel shall be completely acid-resistant. Enamel shall be white unless otherwise noted.

D. Water Closet Performance Requirements:

1. MaP test score of no less than 800.

2. Compatible with 1.1 through 1.6 GPF flushometers.

E. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

2.2 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

A. Water Closets (WC-1): Floor mounted, bottom outlet, top spud.

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

a. American Standard.

b. Kohler Co.

c. Sloan Valve Company.

d. TOTO USA, INC.

2. Bowl:
    a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
    b. Material: Vitreous china.
    c. Type: Siphon jet.
    d. Style: Flushometer valve.
    e. Height: Standard.
    f. Rim Contour: Elongated.
    g. Spud Size and Location: NPS 1-1/2; top.
3. Bowl-to-Drain Connecting Fitting: ASME A112.4.3.
4. Flushometer Valve: Insert Valve Designation.
5. Toilet Seat: WCS-1.
6. Water-Closet Mounting Height: Handicapped/elderly according to ICC/ANSI A117.1.

2.3 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

A. Lavatory (L-1): Oval, self-rimming, vitreous china, counter mounted.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. American Standard America.
        b. Kohler Co.
        c. Sloan Valve Company.
        d. TOTO USA, INC.
        e. Zurn Industries, LLC.
    2. Fixture:
        a. Standard: ASME A112.19.2/CSA B45.1.
        b. Type: Self-rimming for above-counter mounting.
        c. Nominal Size: Oval, 20 by 17 inches.
        d. Faucet-Hole Punching: Three holes, 2-inch centers.
        e. Faucet-Hole Location: Top.
        f. Mounting Material: Sealant.
    3. Faucet: LF-1.
    4. Supply Fittings: Conform with requirements in "Supply Fittings" Article.
    5. Waste Fittings: Conform with requirements in "Waste Fittings" Article.
    6. Protective Shielding Guards: Conform with requirements in "Protective Shielding Guards" Article.
    7. Thermostatic Mixing Valve: Conform with requirements in Section 22 11 19 - Domestic Water Piping Specialties.

2.4 INDIVIDUAL SHOWERS

A. Individual FRP Showers (SH-1).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Aqua Glass Corporation.
    b. Clarion Bathware.
    c. EverFab LLC.
    d. Florestone Products Co., Inc.
    e. Praxis Industries, LLC.
    f. Sterling.
2. Standards: ANSI Z124.1.2.
3. Type: Sectional unit without top.
4. Style: Handicapped/wheelchair, low-profile bottom.
5. Faucet: SHF-1.
6. Nominal Size and Shape: As shown on drawings.
7. Color: White.
8. Bathing Surface: Slip resistant according to ASTM F 462.
9. Accessories:
    a. Fold-down phenolic seat with stainless-steel support tubing.
    b. L-shape stainless-steel grab bar.
    c. Vertical stainless-steel grab bar.
10. Outlet: Drain with NPS 2 outlet.

2.5 FLOOR-MOUNTED MOP SINKS

A. Mop Sinks (MS-1): Plastic, floor mounted.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. E. L. Mustee & Sons.
    b. Fiat Products.
    c. Zurn Industries, LLC.
2. Fixture:
    a. Standard: IAPMO/ANSI Z124.6.
    b. Material: Cast polymer or fiber-reinforced polymer.
    c. Nominal Size: 24 by 24 by 10 inches.
    d. Rim Guard: Stainless steel on front top surfaces.

e. Color: White.

f. Drain: Grid with NPS 3 outlet.

g. Accessories: 304 stainless steel wall guards on two sides. Minimum 10-inch height and 20-gauge thickness.

3. Mounting: On floor and flush to wall.

4. Faucet: MSF-1.

2.6 FLUSHOMETER VALVES

A. Lever-Handle, Diaphragm Water Closet Flushometer Valves (WCFV-1):

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

a. American Standard.

b. Kohler Co.

c. Moen.

d. Sloan Valve Company.

e. TOTO USA, INC.

f. Zurn Industries, LLC.

2. Standard: ASSE 1037.

3. Minimum Pressure Rating: 125 psig.

4. Features:

a. Include integral check stop and backflow-prevention device.

b. Include trap primer connection for floor drains.

5. Material: Brass body with corrosion-resistant components.

6. Exposed Flushometer-Valve Finish: Chrome plated.

7. Style: Exposed.

8. Water Consumption: As shown on drawings.

9. Minimum Inlet: NPS 1.

10. Minimum Outlet: NPS 1-1/4.

2.7 SOLID-BRASS, MANUALLY OPERATED FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Lavatory Faucets (LF-1): Manual-type, single-control mixing, commercial, solid-brass valve.

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

a. American Standard America.

b. Chicago Faucets; Geberit Company.

c. Delta Commercial.

d. Kohler Co.

e. Moen Incorporated.

f. Speakman Company.

g. T&S Brass and Bronze Works, Inc.

2. Standard: ASME A112.18.1/CSA B125.1.

3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.

4. Body Type: Centerset.

5. Body Material: Commercial, solid brass.

6. Finish: Polished chrome plate.

7. Maximum Flow Rate: As shown on drawings.

8. Maximum Flow: Water volume per metering cycle as shown on drawings.

9. Mounting Type: Deck, exposed.

10. Valve Handle(s): Single lever.

11. Spout: Rigid type.

12. Spout Outlet: Aerator.

C. Sink Faucets MSF-1: Manual type, two-lever-handle mixing valve.

1. Commercial, Solid-Brass Faucets.

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

1) American Standard America.

2) Chicago Faucets; Geberit Company.

3) Elkay Manufacturing Co.

4) Just Manufacturing.

5) Kohler Co.

6) Moen Incorporated.

7) Speakman Company.

8) T&S Brass and Bronze Works, Inc.

9) Zurn Industries, LLC.

2. Standard: ASME A112.18.1/CSA B125.1.

3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.

4. Body Type: Wall-mounted, adjustable arms.
5. Body Material: Commercial, solid brass.
6. Finish: Rough Chrome plated.
7. Maximum Flow Rate: 2.2 gpm.
8. Handle(s): Lever.
9. Mounting Type: Back/wall, exposed.
10. Spout Type: Rigid, solid brass with wall brace.
11. Vacuum Breaker: Required for hose outlet.
12. Spout Outlet: Hose thread according to ASME B1.20.7.

D. Shower Faucets (SHF-1).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Acorn Engineering.
    b. American Standard America.
    c. Chicago Faucets; Geberit Company.
    d. Kohler Co.
    e. Moen Incorporated.
    f. Speakman Company.
    g. Powers.
    h. Zurn Industries, LLC.
2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
3. Shower Valve:
    a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
    b. Body Material: Solid brass.
    c. Finish: Polished chrome.
    d. Shower-Arm, Flow-Control Fitting: Flow rate as shown on drawings.
    e. EPA WaterSense: Required.
    f. Mounting: Exposed.
    g. Operation: Single-handle, twist or rotate control.
    h. Antiscald Device: Integral with mixing valve.
    i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
4. Supply Connections: NPS 1/2.
5. Shower Head:

a. Standard: ASME A112.18.1/CSA B125.1.

b. Type: Handshower with flexible metallic hose, slide attachment, and minimum 36-inch slide bar.

c. Shower Head Material: Metallic with chrome-plated finish.

d. Spray Pattern: Fixed.

2.8 SUPPLY FITTINGS

A. Water Supply Fitting with Integral Check Valve:

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

a. Chicago Faucets, Geberit Company.

b. McGuire Manufacturing.

2. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

3. Standard: ASME A112.18.1/CSA B125.1.

4. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

5. Supply Stops: Chrome-plated-brass, gate-type valve with inlet connection matching supply piping.

6. Operation: Loose key.

7. Risers:

a. NPS 3/8.

b. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

2.9 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain:

1. Lavatory: Grid type with NPS 1-1/4offset and straight tailpiece.

C. Trap:

1. Lavatory:

a. Size: NPS 1-1/2 by NPS 1-1/4.

b. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.

2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers.

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

a. Insul-Tect Products Co.

b. McGuire Manufacturing.

c. Plumberex Specialty Products, Inc.

d. Truebro.

B. Standard: ASTM E84 for flame and smoke spread.

C. Description: Manufactured plastic wraps for covering plumbing fixture trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.11 WATER CLOSET SEATS

A. Water Closet Seats (WCS-1):

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

a. American Standard.

b. Bemis Manufacturing Company.

c. Beneke Manufacturing Company.

d. Church Seats; Bemis Manufacturing Company.

e. Kohler Co.

f. Olsonite Seat Co.

2. Basis of Design: Bemis 1955-CT.

3. Standard: IAPMO/ANSI Z124.5.

4. Material: Plastic.

5. Type: Commercial (Standard).

6. Shape: Elongated rim, open front.

7. Hinge: Check.

8. Hinge Material: Noncorroding metal.

9. Seat Cover: Not required.

10. Color: White.

2.12 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply, sanitary drainage, and vent piping systems to

verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Fixture Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install fixture accessory items, such as water closet seats, lavatory piping jackets.
3. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks.
4. Set floor-mounted sinks in leveling bed of cement grout.
5. Thermostatic Mixing Valves: Provide for fixtures where indicated. Install in accordance with manufacturer's instructions. Unless otherwise indicated, set temperatures for the following:
    a. Lavatories: 110 deg F.

B. Support Installation:

1. Install water-supply piping with stop on each supply to each sink and lavatory faucet.
    a. Exception: Use ball valves if supply stops are not specified with sink.
    b. Install stops in locations where they can be easily reached for operation.
2. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks and lavatories.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet and urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of fixture.
4. Install actuators in locations that are easy for people with disabilities to reach.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.

E. Joint Sealing:

1. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to fixture color.

F. Shower Installation.

1. Assemble shower components according to manufacturers' written instructions.
2. Install showers level and plumb according to roughing-in drawings.
3. Install water-supply piping with stop on each supply to each shower faucet.
    a. Exception: Use ball valves if supply stops are not specified with shower.
    b. Install stops in locations where they can be easily reached for operation.
4. Install shower flow-control fittings with specified maximum flow rates in shower arms.
5. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.
6. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

3.3 ADJUSTING

A. Operate and adjust fixtures and associated controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at flushometer valves or faucets to produce proper flow.

3.4 CLEANING AND PROTECTION

A. Clean fixtures and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed fixtures, trim, and fittings.

C. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

D. Replace fixtures damaged during construction with new fixtures at no expense to the Owner.

END OF SECTION

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SECTION 23 0500

GENERAL HVAC PROVISIONS

PART 1 GENERAL

1.1 CONTRACT DOCUMENTS

A. General HVAC provisions apply to all work performed in Division 23.

B. The Contract Documents are complementary. What is required by anyone, as affects this Division, shall be as binding as if repeated herein.

C. Separation of this Division from other Contract Documents shall not be construed as segregation of the Work.

D. Location of equipment on Drawings is approximate. Plan exact location with respect to site measurements and work of other trades prior to starting work. If measurements differ slightly, modify work. If measurements differ substantially, notify Architect/Engineer and Owner's Authorized Representative prior to fabrication.

E. Make minor changes in equipment connections and equipment locations as directed or required before rough-in without extra cost.

F. For products specified by listing one or more manufacturers, followed by "Similar to" and one manufacture's model number, the following requirements apply:

1. Approval of each listed manufacturer is contingent upon that manufacturer having a product which meets the specification, fits in the available space, and is comparable to the listed model.

2. Electrical requirements, duct requirements, pipe connections, and space requirements indicated on drawings are based on the listed model and may not be suitable for all manufacturers listed. Provide revisions required to accommodate the model actually furnished.

G. For product specified by listing one or more manufacturers, followed by a model number for each manufacturer, the following requirements apply:

1. Provide one of the listed model numbers or an approved substitution.

2. Electrical requirements, duct connections, pipe connections, and space requirements indicated on the Drawings are based on one of the listed models and may not be suitable for all models listed. Provide revisions required to accommodate the model actually furnished.

1.2 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): A federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority.

B. Owner's Authorized Representative (OAR): Owner's representative with authority to act on Owner's behalf.

C. Architect/Engineer: The design professional leading the design team and can be either an architect or engineer.

D. The words furnish, install and provide are defined as follows:

1. Furnish: To supply and deliver to the project ready for installation and in operable condition.
2. Install: To place in final position, complete, anchored, connected in operable condition.
3. Provide: To furnish and install complete. Includes the supply of specified services.
4. When neither furnish, install or provide is stated, provided is implied.

E. Where content in other sections or divisions is referenced, the words refer and conform are defined as follows:

1. Refer (To): The work referenced in the identified section or division is provided under the referenced section or division. The referenced work is listed for clarity and coordination.
2. Conform (To or With): The work is provided under the section containing the reference and must comply with the requirements of the referenced section or division.

1.3 COORDINATION

A. Check drawings of other trades to avert possible installation conflicts. Should major changes from original drawings be necessary to resolve such conflicts, notify Architect/Engineer and secure written approval and agreement on necessary adjustments before start of work.

B. Architectural drawings govern all other drawings. Consult in detail the door swings, counter heights and similar items affecting work before rough-in.

C. Coordinate identification systems with other trades. All mechanical systems shall use identical piping, valve, and equipment identification and regulatory signage.

1.4 SUBMITTALS AND SHOP DRAWINGS

A. See Division 01.

B. Action Submittal Content.

1. Action submittal information not expressly required by the specifications will not be reviewed.
2. Action submittal information shall be provided in sufficient detail to establish conformance with specified requirements. Where submitted literature includes multiple models, features, or options, the specific models, features, or options proposed shall be clearly indicated. Where a brief inspection shows that product data is not complete, the submittal will be rejected without review.
3. Action submittal data shall be clear, concise, legible, and relevant. Where data is not properly organized and contains significant information that is not relevant, the submittal will be rejected without review.
4. Action submittal requirements are listed in individual specification sections. The following definitions apply.
    a. Materials List: Provide tabular list of materials including specification reference, specification product name, manufacturer, model/part number, and size and/or

quantity where appropriate. Do not include supplemental data, except where specifically requested.

b. Catalog data: Manufacturer's standard product cut sheet.

c. Product Data: Detailed data including dimensions, weight, materials of construction, connections, and all other information needed to confirm that the product conforms to all requirements listed in the individual specification section.

d. Performance Data: Capacity, input, output, flow, etc. as required to confirm that the product meets the performance requirements scheduled in the Specifications or on the Drawings.

e. Wiring Diagrams: Power and control wiring diagrams.

f. Shop Drawings: Construction drawings of items manufactured specifically for this project including dimensions, construction details, weights, and additional information to identify the physical features of the system or piece of equipment.

g. Installation Instructions.

h. Special Requirements Listed: Additional requirements indicated in individual specification sections.

C. Delegated Design.

1. The Contractor shall provide delegated design services where indicated in the Contract Documents and obtain necessary approval from the AHJ. The Contractor shall be responsible for the design, calculations, submittals, permits, fabrication, transportation and installation of these Delegated Design components. The Contractor is responsible to submit all Delegated Design documents required for approvals by regulatory agencies for each item of delegated design work.

2. Delegated design work shall be performed by a properly licensed design professional registered in the State in which the work is performed where required by the AHJ or as specified herein.

3. Comply with requirements of the AHJ over the Work current at the time of submission. The Contractor is responsible to coordinate and submit all material required by the AHJ so review and process of submittals and permits will not adversely affect the construction schedule. Each Delegated Design item requiring review by the AHJ must be provided by the Contractor and all fees and costs associated therewith shall be the Contractor's responsibility at no additional cost to the Owner.

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

a. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

1.5 QUALITY ASSURANCE

A. All materials and equipment provided hereunder shall be installed and started in complete conformance with the manufacturer's recommendations.

B. Asbestos products or equipment or materials containing asbestos shall not be used.

C. Certify that each welder has passed the American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

1.6 DESIGN REQUIREMENTS

A. Equipment and systems provided hereunder shall be rated to provide performance specified and scheduled on Drawings at the elevation of the project site.

B. Materials and equipment provided hereunder shall be rated for the service conditions of the system to which they are connected including but not limited to temperature, pressure, and humidity.

1.7 CODES AND STANDARDS

A. The Work shall conform to the following Codes and Standards.

1. Codes and Regulations of Governing Authority.

2. Americans with Disabilities Act (ADA).

3. Owner's Construction Standards or Guidelines.

B. Contract Documents are indented to comply with refenced Codes and Standards. Any deviation from applicable codes and standards identified in Contract Documents shall be submitted in writing to the Architect/Engineer.

C. Applicable codes and standards shall determine minimum requirements for materials, methods, and labor practices not otherwise stated herein.

1.8 SEQUENCING

A. Testing, adjusting, and balancing of HVAC systems will begin after commissioning construction checks and equipment start-up are complete and Systems Ready to Balance Checklist forms have been executed and submitted.

B. Submit schedule for operator training eight weeks prior to Substantial Completion. Schedule shall include time and duration of each required training session.

C. Submit control verification reports three weeks after Substantial Completion.

D. Submit draft operations and maintenance manuals to Owner’s Authorized Representative 30 days prior to substantial completion.

E. Operator training shall be performed prior to Substantial Completion, or as otherwise approved by the Owner’s Authorized Representative.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

E. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

F. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

G. Replace installed products damaged during construction.

1.10 TEMPORARY SERVICES

A. Provide in accordance with Division 01 as required for completion of work.

B. Maintain existing systems operational. Owner will be responsible to operate and maintain existing equipment during the course of the project. However, any damage to existing equipment resulting directly from work under this Contract shall be repaired by the Contractor at no expense to Owner.

C. All mechanical systems currently operating including HVAC equipment and controls, which serve Owner occupied areas, must be maintained operational during construction. It is the responsibility of the Contractor to provide temporary facilities as required to maintain operation. If any system currently in use must be turned off to perform work, permission must be obtained, and owner notified prior to performing any work.

1.11 OPERATIONS AND MAINTENANCE MANUALS

A. Furnish operation and maintenance data for project, as described herein.

B. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF files.

1. Include a directory of all subcontractors and maintenance contractors with names, addresses, and telephone numbers, indicating the area of responsibility for each.

2. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

3. Provide a composite summary table indicating each item of equipment listed in the operations and maintenance manual and its required maintenance and time period. This summary table shall be the first section in the O&M manual.

4. Manual Content: Manuals shall contain complete information for each item of mechanical, electrical or other operating equipment. Include as applicable:

a. Manufacturer's instructions for installation, startup, operation, inspection, and maintenance.

b. Lubrication schedules.

c. Performance capacity.

d. Final approved product submittals for each product included in project.

1) Mark the model actually provided where the literature covers more than one model. Include all submittal data corrected to "as-built" conditions within the manual.

2) Parts list.

e. Maintenance schedules.

f. Maintenance instructions shall indicate routine-type work with step-by-step instructions that should be performed to ensure long life and proper operations. Recommended frequency of performance shall also be included.

5. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

1.12 RECORD DRAWINGS

A. Provide record "as-built" drawings in accordance with Division 01 requirements. Show all deviations from contract drawings and location of underground lines by accurate dimensions from building lines. Show depth of all stub outs and underground lines. Dimension all concealed piping from column grids or building lines. Alternately, provide electronically using.pdf markup of contract drawings.

PART 2 PRODUCTS

2.1 PRODUCTS AND MATERIALS

A. All materials employed in permanent construction shall be new, full weight, in first class condition, and suitable for space provided. All similar equipment and materials shall be of one manufacturer.

B. Materials and equipment used as the basis of design is scheduled on Drawings or designated in product specifications. If Contractor chooses to use products that is not the basis of design, Contractor is responsible for all re-design and construction costs associated with variations in arrangement, dimension, or capacity. Such work may include, but is not limited to, changes to facility structure or dimensions and revisions to associated mechanical and electrical systems needed to provide equal system performance and maintainability.

2.2 ELECTRICAL EQUIPMENT

A. Electrical Disconnect Switch: Electrical disconnect switches specified for mechanical equipment shall conform to OSHA Lock-out/Tag-out requirements.

B. All electrical equipment shall be listed as approved for its application by the Underwriters Laboratory or other testing agency approved by the State of Oregon Electrical and Elevator Board. Approval indicates agency meets testing standard requirements for electrical safety required by Oregon Revised Statutes 479.510 through 479.855 and Oregon Administrative Rules.

C. Enclosure: Provide the following electrical equipment enclosure types unless specifically stated otherwise in individual specification sections.

1. NEMA 1: Dry, enclosed locations where the ambient temperature will not be outside of the VFD temperature ratings.

2. NEMA 12: Enclosed mechanical spaces equipped with floor drains where dripping or splashing may occur and where the ambient temperature will not be outside of the VFD temperature ratings.
3. NEMA 3R: Outdoors spaces exposed to weather and where NEMA 4 or 4X is not required.
4. NEMA 4: Mechanical spaces where hose directed-water is expected.
5. NEMA 4X: Swimming pool mechanical rooms.
6. Outdoor Enclosures with Temperature Control: NEMA 3R. Provided with a ventilation fan and heater capable of maintaining enclosure temperature within the manufacturer's recommended range. Drive and enclosure shall be a single, UL-listed assembly with single point electrical connections.

2.3 ROOF CURBS, BASES, AND RAILS WITHOUT INTEGRAL VIBRATION ISOLATION

A. Acceptable Manufacturer: 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. Greenheck Fan Corporation.
   2. rps by Duravent.
   3. The Pate Company.
   4. Thybar.Corporation.

B. Related Sections: Refer to Section 230548 - Vibration and Seismic Control for curbs or bases that include integral vibration isolation.

C. Roof equipment curbs, bases and rails shall be provided by supplier of associated equipment and conform to the following requirements and to requirements shown on Drawings:
   1. General:
      a. Submittals: Provide curb, base, and rail submittals as part of associated rooftop equipment submittal packages.
      b. Seismic and Wind Load: Design curbs, bases, and rails to withstand seismic and wind load forces on equipment in accordance with performance requirements listed in Division 23. Provide attachments including:
         1) Equipment to curb, base, or rail.
         2) Curb, base, or rail to building structure.
      c. Provide design calculations verifying that seismic and wind load restraint will comply with the Oregon Structural Specialty Code for the site and the building type listed where required. Drawings, details, and calculations related to seismic and wind load design shall be signed and sealed by an engineer specializing in the associated work and registered in State of the project site.
   2. Coordination: Coordinate configuration and height of curb with roofing contractor.
      a. Provide sloped curbs to match roof conditions.

b. Curbs shall be provided with cants compatible with roofing system and roofing insulation thickness in accordance with roofing manufacturer's recommendations.

c. Provide wood nailers where required.

d. Provide 16-inch curbs, except as otherwise specified or shown on Drawings. Adjust curb height for roof insulation thickness. Exposed curb height above insulation shall be not less than twelve inches.

3. Equipment Curbs.

a. Base: Constructed of G90 galvanized steel framing. Design internal framing to accommodate ductwork, air plenums, piping and conduit as shown on Drawings. Components shall be non-combustible.

b. Damper Tray: Provided by curb manufacturer where required.

c. Insulation: Factory or field applied closed-cell insulation with a minimum R-value of R-4.

d. Furnish curb with integral crickets if required by roof installation.

4. Equipment Curb Bases:

a. Base: 16-inch tall constructed of G90 galvanized-steel framing. Design internal framing to accommodate piping and conduit shown routed through curb housing. Components shall be non-combustible.

b. Platform: Structural deck and minimum 22-gauge 304 stainless-steel cap flashing with welded corner seams. Deck shall support a minimum uniform top loading of 100 pounds per square foot, excluding equipment point loads.

c. Support Channels: Provide structural channel or hat channel welded to top of cap flashing for equipment support and anchorage. Support channel shall be designed to support equipment point loading and located for attachment to equipment base connections. Channel shall be sized to provide required horizontal bearing surface as required by equipment manufacturer and to accommodate vibration isolation.

d. Insulation: Factory or field applied closed-cell insulation with a minimum R-value of R-4.

e. Piping Housing: Provide piping housing at one end of curb for routing piping and conduit up through curb to equipment when shown on Drawings. Housing shall have sealable side openings to provide waterproof penetrations. Housing material and construction shall match cap flashing and have removable top access cover.

f. Similar to The Pate Company, Solid Cover Equipment Base.

5. Rails: Linear structural equipment support bases for equipment point loading.

a. Base: Constructed of G90 galvanized-steel framing. Components shall be non-combustible.

b. Cap Flashing: Minimum 22-gauge, 304 stainless-steel, cap flashing with welded corner seams.

c. Similar to Thybar Corp., Equipment Mounting Supports.

6. Pipe Curb:

a. Base: 18-inch height. Constructed of G90 galvanized-steel framing. Components shall be non-combustible. 1-1/2 inch closed cell rigid Insulation.

b. Cap Flashing: Minimum 22-gauge, 304 stainless-steel or Thermoplastic Korad Acrylic cap flashing with welded corner seams and raised colar at each pipe penetration. Refer to plans for quantity and size of piping penetrations.

c. Graduated Boot: Manufacturers standard boot. Rated for continuous exposure to outdoor temperatures between -40oF and 200oF. UV rated for continuous sun exposure. Top and bottom stainless steel pipe clamps.

d. Similar to Thybar Corp., Pipe Curb.

2.4 SPECIAL TOOLS AND LUBRICANTS

A. Furnish and turn over to Owner's Authorized Representative, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

B. Grease Guns with Attachments for Applicable Fittings: Provide one for each type of grease required for motor or other equipment.

C. Lubricants: Provide a minimum of one quart of oil, and one pound of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

PART 3 EXECUTION

3.1 ACCESS TO EQUIPMENT AND ACCESSORIES

A. Install equipment with sufficient access for service. Where not conveniently accessible by other means, provide adequately sized access doors for valves, dampers, motors, belts, and all other mechanical equipment requiring access for removal or maintenance. Type, size and exact location of access doors shall be coordinated with Architect/Engineer prior to work.

B. Provide clearances for maintenance access as indicated on Drawings or as recommended by manufacturer. If access requirements shown on Drawings conflict with manufacturer's recommendations, provide larger clearance of the two.

C. If equipment location shown on Drawings does not allow required access, notify Architect/Engineer prior to start of work.

D. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to Architect/Engineer for resolution prior to starting work.

E. Provide access doors as required for access to mechanical equipment. Doors required for access are not necessarily shown on Drawings. Consult with Architect/Engineer for direction on placement of required doors not shown on Drawings.

1. Comply with manufacturer's instructions for installation of access doors. Provide all necessary support and supplemental framing for assembly where the access doors are required. Set accurately in position, plumb, level, and flush to adjacent finish surfaces; and secure to support.

F. Where ladder access is required to service elevated components, provide an

installation that provides for sufficient access within ladder manufacturer's written instructions for use.

G. Comply with OSHA regulations.

3.2 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, lights, electrical outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

B. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.

C. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.

D. Minor Piping: Small diameter pipe runs from drips and drains, water cooling, and similar minor services are generally not shown but must be provided. Contractor is responsible to provide all such minor piping where needed to maintain mechanical spaces clean and dry and to allow full equipment function and maintenance.

E. Interconnection of Controls and Instruments: Generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments, and computer workstations. Comply with NFPA-70.

F. Work in Existing Building: Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Owner’s Authorized Representative. Locate openings that will least affect structural slabs, columns, ribs, or beams. Refer to the Architect/Engineer for determination of proper design for openings through structural sections and obtain layout approval prior to cutting or drilling into structure. After Architect/Engineer approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.

G. Switchgear Drip Protection: Do not install piping above electrical switchgear.

H. Inaccessible Equipment.

1. Where the Owner’s Authorized Representative determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.

2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.3 RIGGING

A. Design is based on use of available structure without modification except as specifically shown. Existing openings in building structures are planned to accommodate design scheme.

B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Architect/Engineer under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.

C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility.

D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Where it is not clear that the building structure has adequate capacity to support rigging, Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to existing building structure, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.

E. Restore building to original condition upon completion of rigging work.

3.4 EXISTING EQUIPMENT REUSED OR RELOCATED

A. All equipment designated as existing or furnished by Owner shall be cleaned and repaired before reinstallation. Any items requiring repair shall be brought to the attention of the construction manager before the item is reinstalled. Damage not brought to the attention of the construction manager shall be deemed the result of reinstallation of the item and shall be repaired without expense to the Owner.

3.5 ROOF CURBS, BASES, AND RAILS WITHOUT INTEGRAL VIBRATION ISOLATION

A. Curb, Base, Rail Support, Field Built-Up: Install roof curbs, bases, rails on roof structure, level and secure, according to Division 7. Install and secure equipment, and coordinate roof penetrations and flashing with roof construction.

3.6 LUBRICATION

A. Lubricate all devices requiring lubrication prior to initial operation. Field check all devices for proper lubrication.

B. Equip all devices with required lubrication fittings or devices.

C. All lubrication points shall be accessible without disassembling equipment, except to remove access panels.

3.7 CLEANING SYSTEMS

A. General: After all equipment, pipes and duct systems are installed, system shall be thoroughly cleaned. Remove all stickers and tags from equipment or fixtures. Clean all piping systems prior to installation of insulation or painting.

B. Hydronic Piping: Clean and flush hydronic piping and strainers as required to complete work described in Section 232513 - Water Treatment for Hydronic Systems.

C. Air Distribution Duct System:

1. Remove all debris from system before operation. Under no circumstances shall system be operated without filters. Replace filters used during construction with new filters.

2. Repair or replace any discolorations or damage to system, building finish, or furnishings resulting from Contractor’s failure to properly clean system.

3.8 START UP

A. The Mechanical Contractor shall be responsible for proper operation of all systems and shall coordinate startup procedures, calibration and system checkout. System operational problems shall be diagnosed and corrected as required for system operation prior to Substantial Completion inspection.

B. Start equipment in accordance with manufacturer's recommendations and under manufacturer's supervision where required. Ensure that associated filters, strainers, electrical overloads, and other devices intended to protect the equipment are installed and functional prior to startup.

C. Verify that piping has been flushed and cleaned prior to startup.

D. The Mechanical Contractor shall perform TAB system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. TAB system-readiness checklists will be provided by the TAB Specialist. See Section 230593 - Testing, Adjusting, and Balancing for HVAC.

3.9 DEMONSTRATION

A. General: After installation is complete, demonstrate to Engineer and Owner's Authorized Representative satisfaction as being complete and operational and entirely in conformance with Contract Documents.

B. Preparation: Prior to demonstration, submit check-off list indicating completeness of submittals and certificates of compliance for review to Owner's Authorized Representative. Operate completed system for one week. Verify that control verification is complete and verification report has been approved by Architect/Engineer.

C. Arrange for demonstration with Owner's Authorized Representative, Engineer, required factory technicians, and installer at least one week in advance of demonstration.

3.10 TRAINING

A. Instruct Owner in proper operation and maintenance of equipment and systems. Instruction shall generally include topics listed in manufacturer's operations and maintenance manual. Operator instructions shall cover all aspects of manual, automatic, and safety controls. Contractor shall also instruct the Owner in the general configuration of systems and location of equipment and components.

B. Furnish competent qualified technicians knowledgeable in the building HVAC systems and equipment provided for this project for a minimum of four hours on-site to instruct Owner in operation and maintenance of systems and equipment. This figure does not include additional training noted under individual specification sections. Contractor shall keep a log of this instruction including date, times, subjects, and those present and shall present such log when requested by Engineer. Contractor shall coordinate training with Owner's Project Manager and provide a schedule for training minimum two-weeks prior to Substantial Completion. All training shall be complete 30-days after Substantial Completion.

C. Contractor shall furnish training by equipment manufacturers in addition to training described in this section where specifically listed in other sections. Contractor shall

schedule training with Owner's Project Manager minimum 48-hours prior to training session. Equipment shall be fully operational prior to scheduling training session. Manufacturer's field start-up, adjustment, and service will not fulfill manufacturer's training requirement.

D. Contractor shall coordinate operator training with the Owner's Authorized Representative as follows:

1. Training Schedule: Contractor shall develop and submit a training schedule listing all required training including contractor training, manufacturer training, and factory training as specified for approval by the Owner's Authorized Representative.

2. Training Record and Evaluation Section: Contractor shall maintain a Training Record documenting attendees and duration of each training session. The Contractor shall complete Training Record after each training session. Submit training record when all training is complete.

END OF SECTION

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SECTION 23 0513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, squirrel-cage induction and electrically commutated motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40°C and at altitude of 3,300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 SINGLE-PHASE ELECTRICALLY COMMUTATED MOTORS

A. General: Electrically commutated, variable-speed, DC, brushless, direct drive type. Motor rotor shall be permanent magnet type with near zero rotor losses.

B. Bearings: Heavy duty, pre-lubricated, antifriction ball bearings.

C. Motor Controller: Single-phase integrated controller/inverter that operates the wound stator and senses rotor position to electronically commutate the stator. Motors designed for synchronous rotation and to overcome reverse rotation.

1. Operating Speed: Controllable from 100% to 20% of full speed.
2. Motor Control: Remote digital input.
3. Speed Control: Provide either manual or remote speed control input as specified and as required to perform intended function:

a. Manual: Potentiometer dial mounted on the motor.

b. Remote modulating analog input: 4-20mA or 0-10 VDC.

4. Soft-start function to reduce inrush current at start-up.

5. Overcurrent Protection.

6. Thermal Overload Protection.

D. Electrical Input: Single phase, 60 hertz. Voltage as required or as scheduled on drawings.

E. Efficiency: Motor shall be minimum of 70% efficient over entire operating range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify motor mounts are compatible with motor frame.

3.2 INSTALLATION

A. Motors Used with Variable Frequency Controllers: Arrange location of motor, variable frequency controller and electrical wiring to ensure the distance from motor to inverter does not exceed manufacturer recommended maximum length.

3.3 APPLICATION

A. EC Motor Speed Control.

1. Remote speed control where required for variable volume applications to perform specified control sequences.

2. Manual speed control for constant volume applications.

END OF SECTION

SECTION 23 0529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Design and installation of hangers and supports for HVAC piping and equipment provided in Division 23. Exceptions include equipment whose structural attachment has been designed by the design team structural engineer.

1.2 DEFINITIONS

A. ASCE: American Society of Civil Engineers.

B. ASME: American Society of Mechanical Engineers.

C. ASTM: American Society for Testing and Materials.

D. MFMA: Metal Framing Manufacturers Association.

E. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.3 PERFORMANCE REQUIREMENTS

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

1. Supports for multiple pipes, including pipe stands, shall be capable of supporting combined weight of supported systems, system contents, and test water.

2. Equipment supports shall be capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 23 05 00 - General HVAC Provisions Submittal requirements indicated by column number designation as follows:

1. Materials List.

2. Catalog Data.

3. Detailed Data.

4. Performance Data.

5. Wiring Diagrams.

6. Shop Drawings.

7. Installation Instructions.

8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Pipe Hangers and Supports		X						
Thermal Hanger Shield Inserts		X						
Roof Mounted Pipe Stands		X						
Fabricated framing & support assemblies								X

B. Shop Drawings:

1. Plans showing type and location of supports and assemblies. Provide full or half size copies of piping plans from the Contract Documents or coordination drawings, showing location and type of each support component to be installed. Drawings shall consist of mechanically reproduced copies of the Contract Documents, or new drawings custom drafted specifically for the Work of this Project. Each drawing shall be printed on a single sheet.

2. Detail fabrication and assemblies for support assemblies including metal framing systems, equipment supports, trapeze hangers, pipe support stands to comply with performance requirements and design criteria. Assemblies may be pre-engineered or custom designed for the application.

3. Detail anchorages and attachments to structure. Where walls, floors, slabs or supplementary steel work are used for support, details of acceptable attachment methods must be included and approved before the condition is accepted for installation. Drawings must include spacing and static loads at all attachment and support points.

1.5 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper-Coated Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. Manufactured Metal Framing Systems:

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

a. B-line, an Eaton business.

b. Thomas & Betts Corporation, a member of the ABB Group.

c. Unistrut, part of Atkore International.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

3. Standard: MFMA-4.

4. Channels: Continuous slotted steel channel with in-turned lips.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

7. Metallic Coating: Pre-Galvanized Hot Dipped, ASTM A653, 0.75 MIL

2.4 INSULATION INSERTS

A. General: Insulation insert for use with MSS Type 40 protection shield.

B. Insulation-Insert Material for Cold Piping:

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

a. Foamglas.

2. ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength and vapor barrier.

3. ASTM C1126 Type III phenolic foam with factory laminated ASJ.

a. 1-1/2” to 2-1/2” pipe size: 32 psi at load point.

b. 3” to 6” pipe size: 85 psi at load point.

c. 8” to 12” pipe size: 135 psi at load point.

C. Insulation-Insert Material for Hot Piping, 200°F and less:

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

a. Insultherm.

b. Johns Manville.

c. Resolco, Inc.

2. ASTM C1126 Type III phenolic foam with factory laminated ASJ.

a. Maximum Temperature: 220oF.

b. Maximum Load:

1) 1-1/2” to 2-1/2” pipe size: 32 psi at load point.

2) 3” to 6” pipe size: 85 psi at load point.

3) 8” to 12” pipe size: 135 psi at load point.

D. Insulation-Insert Material for Hot Piping, greater than 200°F:

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

a. Johns Manville.

b. Thermal Pipe Shields.

2. Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) minimum compressive strength.

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

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

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

2.6 ROOF MOUNTED PIPE STANDS

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

1. B-Line.

2. Erico.

3. Eaton.

B. Polyethylene, polypropylene block with embedded 14-gauge hot dipped galvanized steel strut channel Similar to B-line Dura-Blok, Erico Pyramid ST.

2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Non-staining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Roof Pipe Stand Installation: Mount on smooth roof surface. Do not penetrate roof membrane.

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 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. Coordinate with Section 23 05 48 - Vibration and Seismic Controls for HVAC for interrelated work.

J. Install building attachments within concrete slabs or to structural steel where possible. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) 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.

M. Insulated Piping:

1. Piping Operating less than 180 degrees:
    a. All Piping 1-1/2-inches and Larger: Provide Insulation Insert with MSS Type 40 protection shield.
    b. All Piping 1-1/4-inches and smaller: Provide MSS Type 40 protection shield.
2. Shield Dimensions for Pipe: Not less than the following:
    a. NPS (Nominal Pipe Size) 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
    d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
    e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
3. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
4. Insulation Inserts: Same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

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

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

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

3.3 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 HANGER SPACING

A. Spacing Table

HYDRONIC PIPING SPACING TABLE	Maximum Horizontal Span	Maximum Vertical Spacing
Carbon Steel and Stainless-steel		
1-1/4 inch and smaller	7 feet	15
1-1/2 inch to 2-1/2 inch	10 feet	15
3 inch and larger	12 feet	15
Copper Tubing		
¾ inch and smaller	5 feet	10
1 inch to 2 inch	7 feet	10
2-1/2 inch and larger	10 feet	10
PVC less than 100˚F and CPVC less than 130˚F		
2 inch and smaller	4 feet	10
2-1/2 inch to 4 inch	5 feet	10
6 inch and larger	6 feet	10
PEX		
All sizes	32 inches	10
Cast Iron		
All sizes	5 feet except 10 feet, where 10-foot lengths are installed.	

3.6 ROD SIZES

A. Select rod diameter to not exceed the maximum safe load listed in Table 2 of MSS SP-58-2009.

3.7 HANGER AND SUPPORT TYPE SCHEDULE

A. Single Pipe, Hung and Uninsulated.

1. NPS ½ to NPS 3: Adjustable Steel Band Hanger, MSS Type 7.

2. NPS 4 and Larger: Steel Clevis, MSS Type 1.

B. Single Pipe, Hung and Insulated.

1. Operating Temperature Less Than 140 Degrees: Steel Clevis, MSS Type 1.
2. Operating Temperature 140 Degrees and Above.
    a. NPS ½ to NPS2: Steel Clevis, MSS Type 1.
    b. NPS 3 and Larger: Adjustable Roller Hanger: Type 43.

C. Multiple Pipe Trapeze or Pipe Rack: Trapeze Hanger, MSS Type 59.
1. Uninsulated Piping: Steel Strap.
2. Insulated Piping: Adjustable Roller, MSS Type 43.

D. Single Pipe Floor Support: Adjustable Pipe Support Saddle: MSS Type 38.

E. Vertical Piping: Refer Section 23 05 48 - Vibration and Seismic Controls for HVAC for riser support and restraint.

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

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

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

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

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

K. To eliminate the need for seismic restraint, for piping installation where the distance from the top of the pipe to the structure is 12 inches or less for the entire run, select hanger-rod and building attachments to allow pipe movement without stress on hangers and attachments.

L. Hanger-Rod Attachments: Unless otherwise indicated, provide the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450°F (49 to 232 deg C) piping installations.
3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450°F (49 to 232 deg C) piping installations.

M. Building Attachments: Unless otherwise indicated, provide 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 (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Vertical-Piping Supports: Unless otherwise required, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
3. Refer 23 05 48 - Vibration and Seismic Controls for HVAC for additional riser support requirements.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications.

P. Comply with MFMA-103 for metal framing system selections and applications.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Roof Mounted Piping: Support with Roof Mounted Pipe Stands, except where otherwise detailed on drawings.

END OF SECTION

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SECTION 23 0548

VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Design and installation of equipment attachment to structure, vibration isolation systems, piping riser support, and seismic restraint components listed for new mechanical equipment, ductwork, piping, and related systems provided in Division 23 as scheduled or described herein. Exceptions include equipment whose structural attachment has been designed by the design team structural engineer including:

2. Related Requirements: Refer to Section 230500, - General HVAC Provisions; Roof Curbs, Bases, Rails Without Integral Vibration Isolation for seismic restraint of roof mounted equipment that is not equipped with vibration isolation.

1.2 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning & Development (for the State of California).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.

a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.

b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. Provide a delegated submittal package comprised of drawings, details, and calculations signed and sealed by an engineer specializing in the associated work and registered in Oregon. Submittals shall indicate full compliance with the device specification in Part 2. Any deviation shall be specifically noted and subject to engineer approval. Submittals

shall include device dimensions, placement, and attachment and anchorage requirements.

2. All restraining devices shall have a pre-approval number from California OSHPD or some other organization acceptable to the Authority Having Jurisdiction. Where pre-approved devices are not available, provide submittals based on independent testing or calculations stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of Oregon.
3. Ductwork and Piping Restraint:
    a. Provide full or half size copies of ductwork and piping plans from the Contract Documents or coordination drawings, showing location and type of each vibration isolation component and seismic restraint to be installed. Drawings shall consist of mechanically reproduced copies of the Contract Documents, or new drawings custom drafted specifically for the Work of this Project. Each drawing shall be printed on a single sheet.
    b. Provide piping and ductwork restraint assembly construction and installation details. Assemblies may be pre-engineered or custom designed for the application.
    c. Provide spring hangers or spring floor supports for the first three supports for piping and ductwork from any equipment that produces vibration. The spring deflection shall match the equipment isolation deflection.
    d. Provide spring hangers or spring floor supports for the first three supports from any vertical riser greater than 20 feet in elevation.
    e. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
4. Equipment Restraint.
    a. Select vibration isolators and accessories as scheduled and as required to meet seismic restraint requirements.
    b. Provide equipment seismic restraint assembly construction and installation details. Assemblies may be pre-engineered or custom designed for the application. Include method of attachment to supporting structure.
    c. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
    d. For equipment mounted outdoors, include wind load in determining the necessary attachment and restraint requirements.
5. Calculations: Provide design calculations to verify that seismic and wind load restraint will comply with the current Oregon Structural Specialty Code for the site and the building type listed.
6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, seismic loads, and location of spring hangars needed to ensure

piping and ductwork is properly supported throughout. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

A. Provide three copies of the seismic restraint system Engineer's inspection report.

B. Provide a written authorization letter from the seismic restraint Engineer authorizing a representative to provide the inspection if a designated representative is used. Describe the representative's qualifications.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide seismic and wind load design in accordance with the current Oregon State Structural Specialty Code and ASCE/SEI 7.

B. Refer to structural notes for project specific seismic requirements.

C. Risk Category: IV

D. Component Importance Factor Ip = 1.5.

2.2 ISOLATION PADS

A. Elastomeric Isolation Pads: (EP-1).

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

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. Vibro-Acoustics.

2. Basis of Design: Mason Type Super WM Pads.

3. Fabrication: Neoprene waffle pad. 3/4-inch thick. 40 durometer. ¼-inch thick steel load distribution plate.

4. Size: Factory or field cut to match requirements of supported equipment.

5. Accessories: Bolt isolator washer bushings where equipment is bolted to structure. Similar to Mason Type HG.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double Deflection Restrained Elastomeric Isolation Mounts: (EM-1).

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

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. Vibro-Acoustics.

2. Basis of Design: Mason Industries Type BR.

3. General: Neoprene mountings with a minimum static deflection of 0.2-inches and all directional seismic capability. Constructed with ductile iron casting containing two separated and opposing molded neoprene elements.

2.4 FREE STANDING SPRING MOUNTS

A. Laterally Stable, Open-Spring Mount: (SM-1).

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

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibro-Acoustics.

2. Basis of Design: Mason Industries Type SLF.

3. General: Free-standing spring isolators. Laterally stable without housing. Complete with molded neoprene cup or ¼-inch neoprene acoustical friction pad between the baseplate and the support.

4. Provided with leveling bolts rigidly bolted to the equipment.

5. Spring diameters not less than 80% of the spring height at rated load.

6. Minimum additional travel to solid equal to 50% of the rated defection.

B. Freestanding, Seismically and Vertically Restrained, Open-Spring Isolators: (SM-3).

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

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. Vibro-Acoustics.

2. Basis of Design: Mason Industries Type SLR or SLRS.

3. Free standing springs, laterally stable and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the spring and the mounting baseplate.

4. Spring diameter no less than 80 percent of the compressed height of the spring at rated load.

5. Spring to have an additional minimum travel to solid equal to 50 percent of the rated deflection.

6. Mount housing shall include vertical limit stops to prevent spring extension when weight is removed.

7. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal directions.

8. A minimum clearance of ¼-inch shall be maintained around restraining bolts so as not to interfere with the spring action.

9. Mountings shall have an Anchorage Preapproval Number from OSHPD in the State of California certifying the maximum certified horizontal and vertical load ratings.

2.5 SNUBBERS

A. Seismic Snubber (SS-1).

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

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

2. Basis of Design: Mason Industries Type Z-1225 or Series Z-1011.

3. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

a. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.

b. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

c. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.

2.6 SPRING HANGERS

A. Spring and Neoprene Hanger with Vertical Restraint: (SH-1).

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

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. Vibro-Acoustics.

2. Basis of Design: Mason Industries Type RW30N.

3. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

5. Minimum Additional Travel: 50 percent of the required deflection at rated load.

6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

10. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.7 RESTRAINT CHANNEL PIPE CLAMP

A. Description: Restraint Channel with Cushion Clamp: (RC-1).

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

1. B-line, an Eaton business.

2. Hilti, Inc.

3. Unitstrut.

C. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end. Provide other matching components. Corrosion-resistant coating; rated in tension, compression, and torsion forces.

D. Accessories:

1. Neoprene clamp cushion. Similar to Unistrut, Cush-A-Clamp.

2.8 RESTRAINT CABLES

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

1. Kinetics Noise Control, Inc.

2. Mason Industries, Inc.

3. Vibro-Acoustics.

B. Basis of Design: Mason Industries SCB/H.

C. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.9 ANCHOR BOLTS

A. Mechanical Anchor Bolts.

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

a. B-line, an Eaton business.

b. Hilti, Inc.

c. Kinetics Noise Control, Inc.

d. Mason Industries.

e. Vibro-Acoustics.

2. Basis of Design: Mason Industries SASE, SAST.

3. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

B. Adhesive Anchor Bolts.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Hilti, Inc.
    b. Kinetics Noise Control, Inc.
    c. Mason Industries.
    d. Vibro-Acoustics.
2. Basis of Design: Mason Industries SRA.
3. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.10 SEISMIC-RESTRAINT ACCESSORIES

A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

PART 3 EXECUTION

3.1 GENERAL

A. Coordinate locations and sizes of structural supports with locations of vibration isolators and seismic/wind restraints (e.g., roof curbs, cooling towers, air-cooled chillers, etc.).

B. Isolated and restrained equipment, duct and piping located on roofs must be attached to the structure. Intermediate supports between the restraint and structure that are not attached to the structure must be approved the project structural engineer or by the restraint manufacturer.

C. Block and shim all bases level so that all ductwork, piping and electrical connections can be made to a rigid system at the proper operating level before isolators are adjusted. Ensure that there are no rigid connections or incidental physical contacts between isolated equipment and the building structure or nearby systems.

D. Ensure housekeeping pads have adequate space to mount equipment and isolator housings and shall also be large enough to ensure adequate edge distance for isolator

anchors to prevent breakout.

E. Select and locate vibration isolation equipment to give uniform loading and deflection, according to weight distribution of equipment.

3.2 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.3 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on seismic design documents to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.4 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Install all equipment in accordance with manufacturer's recommendations and as shown on seismic design documents.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Elastomeric Isolation Pads: Provide for entire weight bearing surface of equipment base, or as recommended by equipment manufacturer.

D. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Ductwork Restraints:

1. Space lateral supports a maximum of 40 feet (12 m) on center and longitudinal supports a maximum of 80 feet (24 m) on center.

2. Brace a change of direction longer than 12 feet (3.7 m).

3. Provide spring hangers supports for the first three supports from any equipment that produces vibration.

F. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet (12 m) on center and longitudinal supports a maximum of 80 feet (24 m) on center.
3. Brace a change of direction longer than 12 feet (3.7 m).
4. Provide spring hangers or spring floor supports for the first three supports from any equipment that produces vibration.
5. Provide spring hangers or spring floor supports for the first three supports from any vertical riser 1-1/2 inch and larger and greater than 20 feet in elevation.

G. Install cables so they do not bend across edges of adjacent equipment or building structure.

H. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

I. Install bushing assemblies for anchor bolts for floor-mounted equipment or rigid equipment bases that are mounted on resilient pads and mounting gaskets, arranged to provide resilient media between anchor bolt and mounting hole.

J. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

K. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

L. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Equipment Piping Connection:

1. Provide flexible pipe connectors at all equipment connections to allow seismic motion of piping relative to equipment. Refer to Section 232116 - Hydronic Specialties.
2. Provide equipment connectors for all motor driven equipment and components connected to such equipment.
3. Provide equipment connectors for non-motor drive equipment as detailed and as otherwise specified.
4. Flexible connectors as listed in Section 232116 - Hydronic Specialties must be selected to allow seismic movement without exceeding acceptable nozzle loads on equipment connections. Acceptable nozzle loads provided by manufacturer.
5. Install flexible pipe connectors and hoses on the equipment side of shutoff valves.

3.6 FIELD QUALITY CONTROL

A. After installation of seismic and vibration control devices is complete and verified as fully functional, Contractor shall notify Engineer and seismic restraint designer that equipment is ready for inspection.

B. Seismic restraint system Engineer shall inspect the installation to verify that seismic restraints are installed and adjusted in conformance with approved shop drawings and no additional restraints are necessary based on field conditions. Alternately, the restraint system Engineer may designate a qualified representative to provide the inspection. The representative may not be an employee of the installing Contractor or Subcontractor.

C. Prepare inspection reports.

3.7 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.8 HVAC VIBRATION CONTROL AND SEISMIC RESTRAINT DEVICE SCHEDULE

A. VIBRATION ISOLATION AND SEISMIC RESTRAINT SCHEDULE

EQUIPMENT	SLAB ON GRADE	ABOVE GRADE (<20 FT SPAN)	ABOVE GRADE (20-30 FT SPAN)	ABOVE GRADE (30-40 FT SPAN)
	Components / Static Defl. (in)	Components / Static Defl. (in)	Components / Static Defl. (in)	Components / Static Defl. (in)
OTHER MECHANICAL EQUIPMENT				
Fan-Coils, Fan Powered Boxes - Suspended		SH-1 / 1.5”		
Condensing Units		SM-3 / 0.75”		
Exhaust Fan		SS-1 SM-1/ 0.75"		

END OF SECTION

SECTION 23 0553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

1.3 COORDINATION

A. Coordinate with Division 22. Match manufacturer, type, and style of identification used.

PART 2 PRODUCTS

2.1 GENERAL

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

1. Brady Corporation.
2. Marking Services, Inc.
3. Seton Identification Products.

2.2 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: 0.025-inch0.025-inch aluminum. Predrilled or stamped holes for attachment hardware.
2. Letter Color: Black.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch2-1/2 by 3/4 inch.
4. Minimum Letter Size: 1/4 inch1/4 inch for name of units if viewing distance is less than 24 inches24 inches, 1/2 inch1/2 inch for viewing distances up to 72 inches72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick1/8-inch-thick, and having predrilled holes for attachment hardware.
2. Engraved to show white lettering on black background except for labels attached to ceiling grid or located within finished spaces shall have black lettering on white background.
3. Maximum Temperature: Able to withstand temperatures up to 160°F160°F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch1/4 inch for name of units if viewing distance is less than 24 inches24 inches, 1/2 inch1/2 inch for viewing distances up to 72 inches72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering. Lettering on labels attached to ceiling grid largest size practical.
6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number.

D. Equipment Label Schedule: For each item of equipment to be labeled, prepare equipment label schedule on 8-1/2-by-11-inch8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

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

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include an arrow indicating flow direction.

1. Lettering Size: Size letters according to ASME A13.1 for piping.
2. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION 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. Ceiling Grids and Access Openings: Label ceiling grid and wall/ceiling access doors and to indicate key access points for equipment, valves, control devices and other components requiring quick access or routine maintenance. Provide a clear adhesive label and bold black lettering with component identification information, except were Owner has establish identification standard label in accordance with Owner's standards. Place label on ceiling metal grid and not on removable tiles.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. 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. Near each valve and control device.

2. Near each flange.

3. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

4. Near penetrations and on both sides of walls, floors, ceilings, and inaccessible enclosures.

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

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

7. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule: Letter and background color in accordance with ANSI A13.1.

3.5 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.

2. Yellow: For hot-air supply ducts.

3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet50 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION

SECTION 23 0593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing air systems and equipment.
2. Balancing hydronic piping systems and equipment.
3. Testing, adjusting, and balancing existing systems and equipment.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB Specialist: An independent entity meeting qualification to perform TAB work.

E. TAB Project Supervisor: Certified individual employed by balancing contractor having administrative and technical responsibility for work performed under this Section.

F. TAB: Testing, adjusting, and balancing.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in Part 1 "Quality Assurance" and Part 3 “TAB Specialist.”.

B. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

C. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

D. Instrument Calibration Report: Within 60 days of Contractor's Notice to Proceed. Report to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

E. Progress Reports: Submit the as specified in Part 3 “Progress Reporting.”

F. TAB reports.

1. Draft TAB Report.

2. Certified Final TAB report.

1.4 QUALITY ASSURANCE

A. All work under this Section shall be performed under the direction of the Certified TAB Supervisor.

B. TAB Specialists Qualifications: Certified by AABC or NEBB.

1. TAB Supervisor: Employee of the TAB specialist and certified by AABC or NEBB.

2. TAB Technician: Employee of the TAB specialist working under the supervision of the TAB Supervisor.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

1.5 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 TAB SPECIALISTS

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

1. Air Balancing Specialties.

2. Air Introduction and Regulation, Inc.

3. Neudorfer Engineering, Inc.

4. Precision Test & Balance, Inc.

3.2 EXAMINATION

A. Contract Document Examination:

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

2. Confirm that balancing devices and provisions are included to facilitate TAB work. Provide listing of any devices and provisions required that are on included in the Contact Documents.

3. Contract Documents Examination Report: Based on examination of the Contract Documents, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Construction Examination:

1. Examine the approved submittals for HVAC systems and equipment.
2. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
3. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
4. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
5. Examine test reports specified in individual system and equipment Sections.
6. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
7. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible, and their controls are connected and functioning.
8. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
9. Examine control valves for proper installation and orientation for their intended function of throttling, diverting, or mixing fluid flows. Verify the pipe connections are in accordance with manufacturers recommendations.
10. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
11. Examine system pumps to ensure absence of entrained air in the suction piping.
12. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Strategies and Procedures Plan: Prepare a TAB plan that includes the following:
   1. Equipment and systems to be tested.
   2. Strategies and step-by-step procedures for balancing the systems.
   3. Instrumentation to be used.
   4. Sample forms with specific identification for all equipment.

B. Prepare system-readiness checks of HVAC systems and equipment to be executed by the Mechanical Contractor to verify system readiness for TAB work. Include, at a minimum, the following:
   1. Airside:
      a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
      b. Duct systems are complete with terminals installed.

c. Volume, smoke, and fire dampers are open and functional.

d. Clean filters are installed.

e. Fans are operating, free of vibration, and rotating in correct direction.

f. Variable-frequency controllers' startup is complete, and safeties are verified.

g. Automatic temperature-control systems are operational.

h. Ceilings are installed.

i. Windows and doors are installed.

j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.

b. Piping is complete with terminals installed.

c. Water treatment is complete.

d. Systems are flushed, filled, and air purged.

e. Strainers are pulled and cleaned.

f. Control valves are functioning per the sequence of operation.

g. Shutoff and balance valves have been verified to be 100 percent open.

h. Pumps are started and proper rotation is verified.

i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.

j. Variable-frequency controllers' startup is complete, and safeties are verified.

k. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

1. Comply with requirements in ASHRAE 62.1, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, install test ports and duct access doors as required in Section 233300 - Air Duct Accessories. Otherwise, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 - Duct Insulation, Section 230716 - HVAC Equipment Insulation, and Section 230719 - HVAC Piping Insulation.

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

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

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

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

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

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

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

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

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

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

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

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

K. Verify that air duct system is sealed as specified in Section 233113 - Metal Ductwork.

L. Fan Pressure Measurements:

1. Measure static pressure directly at the fan outlet or through the flexible connection.

2. Measure static pressure directly at the fan inlet or through the flexible connection.

3. Measure static pressure across each component that makes up and air-handling system.

M. Air Inlets and Outlets:

1. Supply Diffusers: Set airflow patterns of adjustable outlets for proper distribution without drafts.

N. Control Parameters and Setpoints:

1. VAV System Supply Air Static Pressure Setpoints: Identify the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

2. Minimum Ventilation Rates: Measure and adjust outside-air, return-air, and relief-air dampers for proper position to achieve minimum outdoor-air conditions. Determine setpoint values for specific control sequences controlling damper operation.

a. VAV systems: Measure ventilation rates at maximum and minimum system airflow conditions.

3. Terminal Units:

    a. Measure airflow and adjust calibration factors at minimum and maximum airflow. If no minimum calibration is available, note any deviation from design airflow.

    b. Calibrate and balance each terminal unit for maximum and minimum design airflow.

4. Airflow Transmitters: Perform field verification and calibration of BAS airflow flow transmitters. Airflow verification shall be performed by duct traverse in straight section of ductwork to provide measurement accuracy of +/- 5%.

5. Record verification measurement. calibration parameters, and setpoints in Final TAB Report.

3.6 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.

2. Water flow rate.

3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.

4. Dry-bulb temperature of entering and leaving air.

5. Wet-bulb temperature of entering and leaving air for cooling coils.

6. Airflow.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.

2. Wet-bulb temperature of entering and leaving air.

3. Airflow.

3.7 PROCEDURES FOR MOTORS

A. Motor Measurement and Verification:

1. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

    a. Manufacturer's name, model number, and serial number.

    b. Motor horsepower rating.

    c. Motor rpm.

    d. Phase and hertz.

    e. Nameplate and measured voltage, each phase.

    f. Nameplate and measured amperage, each phase.

    g. Starter size and thermal-protection-element rating.

    h. Service factor and frame size.

2. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

B. Motor Speed Adjustments:

1. Obtain approval from Engineer for adjustment of fan motor speeds higher than the motor synchronous speed. indicated speed for induction motors.

2. Obtain approval from Engineer prior to making fan-speed adjustments that result in motor operation above the motor RLA. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required motor amperage.

3.8 DUCT LEAKAGE TESTS

A. Verify that proper test methods are used and that leakage rates are within specified tolerances.

B. Report deficiencies observed.

3.9 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

2. Verify that the system static pressure sensor is located in the duct or piping system as specified or as shown on drawings.

3. Verify the operation of valve and damper actuators. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions in Final Report.

3.10 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work. TAB shall be performed to achieve system performance shown on Drawings and as specified. TAB shall be performed for interrelated equipment and systems which are not otherwise modified, but where testing, adjusting, and balancing is required to achieve overall system performance and to maintain existing equipment and systems that are unmodified operating at preconstruction conditions.

1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan speed and the face velocity of filters and coils.

2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.

3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

4. Balance each air outlet.

B. Prepare an Existing Conditions TAB Report documenting inspections and measurements.

3.11 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent or minus 5 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.

3. Heating-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.12 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.

2. Fan curves.

3. Manufacturers' test data.

4. Field test reports prepared by system and equipment installers. Test reports shall be fully executed reports forms confirming to standard NEBB or AABC documentation standards.

5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.

2. Name and address of the TAB specialist.

3. Project name.

4. Project location.

5. Architect's name and address.

6. Engineer's name and address.

7. Contractor's name and address.

8. Report date.

9. Signature of TAB supervisor who certifies the report.

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Settings for supply-air, static-pressure controller.
    g. Other system operating conditions that affect performance.

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

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

3.13 ADDITIONAL TESTS

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

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions. Prepare Seasonal Test Report of measurements and adjustments.

END OF SECTION

SECTION 23 0713

DUCT INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes insulation of HVAC ductwork.

1.2 ACTION SUBMITTALS

A. Provide submittals in accordance with Section 230500 - General HVAC Provisions as follows:

1. Provide catalog data for all products. Indicate thermal conductivity, water vapor permeance, and jackets (both factory and field applied) if any.

1.3 QUALITY ASSURANCE

A. Insulation materials and accessories shall be installed in a professional manner by skilled and experienced workers who specialize in commercial insulation work.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.4 COORDINATION

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

1.5 SCHEDULING

A. If duct leak testing is required, schedule insulation application after systems are tested and, where required. Insulation application may begin on segments that have satisfactory test results.

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

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied Polypropylene-Scrim-Polyester (PSP) jacket or Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

a. CertainTeed Corporation.

b. Johns Manville, a Berkshire Hathaway company.

c. Knauf Insulation.

F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

a. CertainTeed Corporation.

b. Johns Manville, a Berkshire Hathaway company.

c. Knauf Insulation.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

C. FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180°F (Minus 29 to plus 82 deg C).

3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient

services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220°F (Minus 46 to plus 104 deg C).
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

2.4 SEALANTS

A. 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 250°F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft paper backing; complying with ASTM C 1136, Type II.
2. PSP Jacket: White poly-top with a permeance of 0.2 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.6 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

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.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

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.

2.7 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- 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 1-1/2-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. Comply with the following requirements:

    a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

    b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Self-Sticking-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. Comply with the following requirements:

    a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

    b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

    c. Adhesive-backed base with a peel-off protective cover.

5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel or aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

6. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces, free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct 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. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. 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.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. 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.

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 Interior Wall and Partition Penetrations (Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, and manufacturer’s recommended percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install support pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not over-compress insulation during installation.

e. Impale insulation over pins and attach speed washers.

f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

   b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. 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.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for manufacturer’s recommended percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install support pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

   d. Do not over-compress insulation during installation.

e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

   b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner reserves the right to perform tests and inspections.

B. Tests will include removing field-applied jacket and insulation in layers in reverse order of their installation for each duct system schedule as directed by the Owner.

C. If sample inspection reveals noncompliance with requirements, all similar insulation applications will be considered defective Work and will be replaced at no expense to the Owner.

3.7 DUCT INSULATION SCHEDULE

A. Insulate all plenums and ductwork as scheduled with the following exceptions.

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.

2. Factory-insulated flexible ducts.

3. Factory-insulated plenums and casings.

4. Flexible connectors.

5. Vibration-control devices.

6. Factory-insulated access panels and doors.

B. Insulate ductwork located indoors in conditioned spaces:

1. Supply Air.
    a. Insulate ductwork where the air supply temperature is:
        1) More than 10°F below that space cooling temperature setpoint or below 60°F.
        2) More than 15°F above the space heating temperature setpoint.
    b. Exposed rectangular ductwork:
        1) Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density, PSP jacket.
    c. Exposed round or oval ductwork:
        1) Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density, PSP jacket.
    d. Concealed ductwork:
        1) Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density, FSK jacket.
2. Exhaust ductwork requiring condensation control including exhaust ductwork from showers, dishwashers, washdown areas, desiccant dehumidifier reactivation exhaust, and similar applications that produce exhaust with high moisture content.
    a. Insulate same as insulated supply air ductwork.

END OF SECTION

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SECTION 23 0719

HVAC PIPING INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes insulating of HVAC piping.

1.2 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 230500 - General HVAC Provisions.

1. Catalog Data.

2. For each type of product listed, provide thermal conductivity and water-vapor permeance.

1.3 QUALITY ASSURANCE

A. Insulation materials and accessories shall be installed in a professional manner by skilled and experienced workers who specialize in commercial insulation work.

B. Surface-Burning Characteristics: Products shall have flame spread and smoke developed ratings based on test procedures in accordance with NFPA-255 and UL 723. Rating shall be indicated on the product or on the shipping containers.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 - Hangers and Supports for HVAC Piping and Equipment.

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

1.5 SCHEDULING

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

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

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials listed and labeled per UL723 at 25/50, in plenum spaces.

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

a. Aeroflex USA, Inc.

b. Armacell LLC.

2.2 ADHESIVES

A. Materials compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric: Comply with MIL-A-24179A, Type II, Class I.

C. PVC Jacket Adhesive: Compatible with PVC jacket.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180°F.

3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.

2. Service Temperature Range: Minus 50 to plus 220°F.

3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

4. Color: White.

2.4 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784,

Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Johns Manville, a Berkshire Hathaway company.
    b. P.I.C. Plastics, Inc.
    c. Proto Corporation.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Vapor barrier: Composite vapor retarder membrane. Permeance, 0.015 maximum (ASTM E 96. Similar to Polyguard Insulrap 30-SJ, PermaTherm PMZ.

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.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
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 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install 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.

C. Install insulation with longitudinal seams at top and bottom of horizontal runs.

D. Install multiple layers of insulation with longitudinal and end seams staggered.

E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. 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.

J. Where piping connections, accessories, or control components are attached to piping with an operating temperature less than 60oF, insulate piping and projections where condensation may occur.

   1. Piping that has constant or intermittent flow: Insulate to match connected piping.

   2. Piping that does not have fluid flow including connections, nipple, wells or other accessories that penetrate insulation and are constructed from materials other than stainless steel, copper, brass, or plastic shall be insulation up to connected devices including pressure relief valves, field mounted control devices, pressure sensing tubing.

K. Apply insulation and jacket manufacturer approved adhesives, mastics, and sealants at recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

   1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Manholes.

5. Handholes.

6. 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 Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover for removable basket flange. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. 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 at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Installation shall follow the manufacturer's installation instructions or ASTM C 1710.

C. Insulation Installation on Pipe Flanges:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. Install pipe insulation to outer diameter of pipe flange.

3. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

4. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

5. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 PIPING INSULATION THICKNESS

A. General.

1. For piping smaller than 1-1/2 inches and located in partitions within conditioned spaces, reduction of thickness by 1-inch permitted to a thickness not less than 1-inch.

B. Insulation installed overheat trace for freeze protection: 1-inch thickness.

C. Serviceable components, connections, and couplings.

1. Install Pre-manufactured Removable Insulation Systems at the following:
    a. Valves, manual and automatic.
    b. Flanges and unions requiring access to allow equipment service.
    c. Mechanical couplings requiring access to allow equipment service.

D. Flexible Elastomeric Insulation.

1.

FLEXIBLE ELASTOMERIC					
FLUID NORMAL OPERATING TEMPERATURE (°F)	NOMINAL PIPE OR TUBE SIZE (inches)				
	<1	1 to < 1.5	1.5 to < 4	4 to < 8	>= 8
>350	-	-	-	-	-
251-350	-	-	-	-	-
201-250	2.5	2.5	2.5	3	3
141-200	1.5	1.5	2	2	2
105-140	1	1	1.5	1.5	1.5
40-60	0.5	0.5	1	1	1
<40	0.5	1	1	1	1.5

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. For all systems with an operating temperature that may be below ambient conditions, a vapor barrier must be maintained.

C. For piping smaller than 1-1/2 inches and located in partitions within conditioned spaces, reduction of thickness by 1-inch is permitted to a thickness not less than 1-inch.

D. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.

2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Cooling Condensate Drain: Normal operating temperature range 42°F to 55°F:

1. Flexible Elastomeric.

B. Refrigerant Suction and Hot-Gas Piping, Operating temperature below 60°F:

1. Flexible Elastomeric.

3.11 OUTDOOR PIPING INSULATION

A. Refrigerant Suction and Hot-Gas Piping, Operating temperature below 60°F:

1. Flexible Elastomeric.

B. Refrigerant Suction and Hot-Gas Flexible Tubing, Operating temperature below 60°F.

1. Flexible Elastomeric.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Provide jacketing for all outdoor insulated piping.

B. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket. For insulation without factory-applied jacket provide vapor barrier beneath insulation jacket.

C. If more than one material is listed, selection from materials listed is Contractor's option.

D. Piping, Exposed:

1. PVC: 30 mils thick.

END OF SECTION

SECTION 23 0922

GENERAL AUTOMATIC CONTROLS FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work hereunder includes control systems and integration of systems and equipment specified in Divisions 23. Associated work includes but is not limited to:

1. Communication, control wiring, and power wiring as required.
2. Field mounted devices.
3. Automatic control sequence of operations.
4. Other materials and devices not shown as part of other work but necessary to provide mechanical and electrical system control and monitoring sequences specified.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Coordinate with other trades to ensure delivery and correct installation of products furnished but not installed under this section. Coordination to include a review of schedule, manufacturer's installation requirements, and equipment locations. Such products include but are not limited to the following:

1. Dampers.
2. Actuators.

1.3 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Coordinate with other trades to ensure correct installation and control of products installed but not furnished under this section. Such products include but are not limited to the following:

1. Thermostats furnished with packaged equipment.

1.4 SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 230500 - General HVAC Provisions. Submittal requirements indicated by column number designation as follows:

1. Materials List.
2. Catalog Data.
3. Product Data.
4. Performance Data.
5. Wiring Diagrams.
6. Shop Drawings.
7. Installation Instructions.

8. Special Requirements listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
All Products This Section								X

B. Special Requirements:

1. Submittals prior to starting work:

a. Submit in accordance with Section 01 33 00 - Submittal ProceduresDivision 01 and Section 230500 - General HVAC Provisions within 6 weeks of Notice to Proceed.

b. When manufacturers' product information applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the pertinent specification or drawing.

c. Control Hardware: Provide a complete bill of materials of control system hardware indicating quantity, manufacturer, model number, and technical data. Technical data shall include performance curves, product specifications sheets, and installation/maintenance instructions.

d. Controlled Systems:

1) Provide a schematic wiring diagram for each controlled system. Label all elements. Label all terminals.

2) Provide a mounting, wiring, and routing plan-view drawing. Layout to account for HVAC, electrical, and other system design and layout requirements.

2. Closeout Submittals:

a. Submit in accordance with SECTION 01 78 39 - Project Record DocumentsDivision 01.

b. Record documents shall include the following:

1) Project record drawings. Project record drawings will be as-built versions of the Shop Drawings. Include one set of digital media.

1.5 QUALITY ASSURANCE

A. All products used in this application, except for those specifically indicated for reuse, shall be new and under current manufacture and shall be the most recent version offered by the manufacturer for the application. Spare parts shall be available from the manufacturer for at least five years after final completion.

PART 2 PRODUCTS

2.1 CONTROL DEVICES

A. Relays and Switches:

1. Single Phase Motor Control Relays:

a. Acceptable Manufacturer: Greenheck, Veris.

b. General: Industrial grade load-switching relay, current status switch, and Hand-Off-Auto switch for control of fractional horsepower single-phase motors. The relay,

current sensor, and HOA switch are combined in a series circuit. Once an H5xx is wired in series between the power source and motor, all three components are installed.

c. Relay: Contacts rated for connected motor load, SPST relay is field-selectable for N.O. or N.C. operation. LED status indicator light.

d. Current Status Switch: Adjustable setpoint.

e. Housing: Surface mounted. The housing provides physical separation and multiple wiring exits to isolate control and high voltage wiring.

f. Similar to Veris, Hawkeye Model 500 Series.

2.2 POWER SUPPLIES AND LINE FILTERING

A. Provide UL listed control transformers. Provide class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

2.3 WIRING AND RACEWAYS

A. Provide wiring, plenum cable, and raceways in accordance with Division 26.

B. All insulated wire to have copper conductor. UL labeled for 90°C service.

2.4 CONTROL SEQUENCE OF OPERATIONS

A. Fan Coil Units FC-1, FC-2, FC-3, FC-4 - Time Schedule Control.

1. Operation: Fan coil operates subject BAS time schedule.

2. Outside air intake Damper: Electrically interlock with motor controller Open damper when fan is on, and close damper when fan is off.

3. Mode Control:

a. Occupied: Fan on.

B. Exhaust Fan EF-1 - Time Schedule Control.

1. Operation: Exhaust fan operates subject BAS time schedule.

2. Shutoff Damper: Electrically interlock with motor controller, unless equipped with backdraft damper. Open damper when fan is on, and close damper when fan is off.

3. Mode Control:

a. Occupied: Fan on.

b. Unoccupied, Warm-up: Fan off.

PART 3 EXECUTION

3.1 COORDINATION

A. Coordinate with controls specified in other sections or divisions. Other sections or divisions include controls and control devices to be part of or interfaced with the control system specified in this section. Integration and coordination with these controls shall be as follows:

1. All communications media and equipment required to interface with equipment specified in other sections provided hereunder unless specifically stated otherwise.
2. Each supplier of a control product is responsible for the configuration, programming, start-up, and testing of that product to meet the Sequence of Operation.
3. Coordinate and resolve any compatibility issues arising between control products provided hereunder and those provided under other sections or divisions.

3.2 WORKMANSHIP

A. Install all equipment in accordance with manufacturers' recommendations.

B. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.

C. Provide sufficient slack and flexible connections in wiring and pneumatic tubing to allow for vibration of piping and equipment.

D. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electric Code.

3.3 EXISTING EQUIPMENT

A. Local Control Panels: Contractor may reuse existing control cabinets to locate new equipment where existing cabinets are in good condition. Remove all redundant equipment within these cabinets. Patch face cover to fill all holes caused by removal of unused equipment.

1. Unless specifically stated elsewhere, Contractor is not responsible for the repair or replacement of existing control system equipment to be reused. Such equipment includes but is not limited to control devices, valves, dampers, or actuators. Should the Contractor find existing equipment requiring maintenance, Contractor shall notify the Owner immediately. Repair will be performed under separate Contract.

B. Room Thermostats or Sensors: Salvage, recondition, and reuse thermostat associated with.

3.4 GENERAL WIRING

A. All control and interlock wiring shall comply with national and electrical codes and Division 26. Where requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.

B. ALL NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.

C. All low-voltage wiring shall meet NEC Class 2 requirements. Low voltage power circuits shall be sub-fused when required to meet Class 2 limits.

D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling plenum and return air plenums, approved cable not in raceway may be used, provided cables are UL listed for the intended application.

E. All wiring in mechanical, electrical, or service rooms and wiring located where it may be subject to damage shall be installed in raceway.

F. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring may not be used for low-voltage wiring except for the

purpose of interfacing the two.

G. Do not install wiring in raceway containing tubing.

H. Where Class 2 wiring is installed exposed, wiring is to be routed parallel or perpendicular to building lines and neatly tied at a maximum of 10-foot intervals.

I. Where plenum cables are used without raceway, support, or anchor cable from building structure. Do not anchor or support cable from ductwork, electrical raceways, piping, or suspended ceiling systems.

J. Provide all wire-to-device connections at terminal block or terminal strip. Provide all wire-to-wire connections at terminal block.

K. Neatly bundle wiring located within enclosures to permit access to devices and terminals.

L. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, Contractor shall provide a step-down transformer.

M. All wiring shall be installed as continuous lengths with no splices permitted between termination points.

N. Install plenum wiring in sleeves where it passes through walls and floors. Provide fire-stop foam where necessary to maintain fire rating.

O. Provide size of raceway and size and type of wire as required by NEC and as required to meet manufacturers' recommendations for connected equipment.

P. Include one pull string in each raceway 1-inch or larger.

Q. Use color coded conductors throughout.

R. Locate control and status relays in designated enclosures only. Such enclosures include packaged equipment control cabinets unless such cabinets also contain Class 1 starters.

S. Conceal all raceways except within mechanical, electrical, or service rooms. Maintain minimum raceway clearance of 6-inches from high temperature equipment such as steam piping or boiler flues.

T. Secure raceways with raceway clamps fastened to the structure and spaced in accordance with code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be supported from ductwork, electrical raceways, piping, or suspended ceiling systems.

U. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all raceways.

V. Maintain updated wiring diagrams (as-built) at site with terminations identified.

W. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3-feet in length and shall be supported at both ends. Flexible metal raceways less than ½-inch electrical trade size shall not be used. In areas exposed to moisture, including but not limited to chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.

3.5 COMMUNICATION WIRING

A. Install in accordance with 3.03 above.

B. Follow manufacturers' recommendations for all communications cabling including but not limited to maximum pulling, tension, and bend radius.

C. Do not install communications cabling in a raceway or enclosure containing Class 1 or other Class 2 wiring.

D. Verify the integrity of the entire network immediately following cable installation using test measures appropriate for each cable.

E. Provide a lightning arrestor between cables and grounds where cable enters or exits a building. Install arrestor in accordance with manufacturers' recommendations.

F. All communications wiring shall be un-spliced length when that length is commercially available.

G. All communications wiring shall be labeled to indicate origination and destination.

H. Ground coaxial cable in accordance with NEC regulations article on "Communications Circuits, Cable and Protector Grounding."

3.6 IDENTIFICATION OF HARDWARE AND WIRING

A. Label all wiring and cabling, including wiring and cabling terminating within factory-fabricated panels, within 2 inches of termination with the BAS address or termination number.

B. Label all pneumatic tubing at each end within 2 inches of termination with a descriptive identifier.

C. Permanently label or code each point of field terminal strips to show the instrument or item served.

D. Identify control panels with minimum ½-inch letters on laminated plastic nameplate.

E. Identify all other control components with permanent labels. All plug-in components shall be labeled so that removal of component does not remove label.

F. Identify room sensors relating to terminal box or valves with nameplate located within sensor cover.

G. Arrange components so that UL or CSA labels are visible after equipment is installed.

H. Identifiers shall match record documents.

I. Provide laminated network communication diagrams, point-to-point wiring diagrams, and process control diagrams in each control panel for control components contained therein.

3.7 CONTROL SYSTEM CHECKOUT AND TESTING

A. Contractor shall completely test and verify specified control system performance. Compile test results and include with written certification.

B. Contractor shall furnish all labor and test apparatus required to install and calibrate all instruments, controls, and accessory equipment furnished hereunder.

C. Contractor shall perform the following testing and verification:

1. Verify that all control and communications wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
2. Enable control systems and verify instrument calibration and end-to-end reporting accuracy of all input devices individually. Perform calibration in accordance with manufacturers' recommendations. Repair or replace all temperature sensors requiring a calibration offset greater than +/- 1°F.
3. Verify control stability and end-to-end reporting requirements are met.
4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that normal positions are correct.
5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, start/stop and span are correct, and direction and normal position are correct.
6. Verify that system operation complies with the sequence of operations. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all control loops and optimum start/stop routines.
7. Alarms and Interlocks:
    a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
    b. Trip interlocks using field contacts to check the logic and ensure that the fail-safe condition for all actuators is in the proper direction.
    c. Test interlock actions by simulating alarm conditions to check the initiating value of the variable and the interlock action.

D. Contractor shall maintain the following documentation:
1. Calibration log including date, time, control system readout, means of verification, verification measurement, and required calibration offset for each analog input.

E. After system operation is completely verified, provide written certification to Owner that systems have been fully tested and are operating according to specifications and ready for functional testing. Provide copies of documentation signed by person performing tests. Documentation to include:
1. Calibration logs.
2. Operational logs.

3.8 DEMONSTRATION AND ACCEPTANCE

A. Demonstrate operation of control system to Owner and Engineer.

3.9 TRAINING

A. Provide a minimum of 4 hours training to Owner's personnel in use and maintenance of control hardware and software.

END OF SECTION

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SECTION 23 2300

REFRIGERANT PIPING AND SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerant piping valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: Hard drawn ASTM B 280, Type ACR cleaned, dehydrated, and sealed. Annealed or hard drawn as scheduled.

B. Long Radius Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join

copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8/A5.8M.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Working Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss Inc.
   b. Heldon Products; Henry Technologies.
   c. Parker Hannifin Corp.
2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
3. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
4. Operator: Rising stem and hand wheel.
5. Seat: Nylon.
6. End Connections: Socket, union, or flanged.
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 275 deg F (135 deg C).

PART 3 EXECUTION

3.1 PIPING

A. Annealed ACR copper piping may be used in the following applications.

1. Downstream of branch connectors in VRF systems.

B. Provide hard drawn ACR copper piping to be used in all other applications.

3.2 FITTINGS

A. Joints.

1. 7/8-inch and Smaller: Solder.
2. 1-1/8 inch and Larger: Braze.

3.3 INSULATION

A. Hard Drawn Piping: Insulate in accordance with Section 230719 - HVAC Piping Insulation.

B. Annealed Piping: Where required to be insulated by Section 230719 - HVAC Piping Insulation pre-insulate with flexible elastomeric insulation. No less than thickness scheduled.

3.4 VALVE AND SPECIALTY APPLICATIONS

A. Provide diaphragm packless valves for isolation as shown on drawings or in accordance with the equipment manufacturer's recommendations.

3.5 PIPING INSTALLATION

A. Install refrigerant piping according to ASHRAE 15.

B. Install hard drawn piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

C. Install annealed copper piping with no joints between equipment connections.

D. Install piping in concealed locations 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.

G. Install piping adjacent to machines to allow service and maintenance.

H. Install piping free of sags and bends.

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

J. Install refrigerant piping in protective conduit where installed belowground.

K. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

L. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.

2. Install horizontal suction lines with a uniform slope downward to compressor.

3. Install traps and double risers to entrain oil in vertical runs.

4. Liquid lines may be installed level.

M. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

N. Install sleeve seals and escutcheons. Comply with requirements for sleeve seals specified in Section 230517 - Sleeves, Sleeve Seals, and Escutcheons for HVAC Piping.

3.6 PIPE JOINT CONSTRUCTION

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

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

C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.

2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.7 HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Section 230529 - Hangers and Supports for HVAC Piping and Equipment.

B. Support multi-floor vertical runs at least at each floor.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping and specialties.

3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

a. Fill system with nitrogen to the required test pressure.

b. System shall maintain test pressure at the manifold gage throughout duration of test.

c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.

d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.9 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.

3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).

END OF SECTION

SECTION 23 3113

METAL DUCTWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes metal ductwork, liner, and related fittings and sealants.

1.2 PERFORMANCE REQUIREMENTS

A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 ACTION SUBMITTALS

A. See Section 230500 for general submittal requirements.

B. Materials List:

1. Shop fabricated ductwork:

C. Catalog Data:

1. Pre-manufactured Ductwork and Fittings.

2. Duct Liner.

1.4 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 D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.

3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. Comply with applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Ductwork Dimensions: Ductwork dimensions shown on drawings are internal dimensions. Adjust outer ductwork size to accommodate liner, double wall construction, or other conditions that would affect interior clear duct opening size.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Sealing Requirements:

1. Concealed: Seal longitudinal seams and transverse joints with liquid duct sealer. Flanged, gasketed joints that meet seal requirements do not require separate duct sealant application.

2. Exposed: Seal non-flanged transverse joints with liquid duct sealer, specified herein, applied to male end fittings only, so that sealer is not visible when joint is assembled.

3. Welded Seam and Joints: Provide continuous air-tight seams and joints for ductwork, fittings, and connections where indicated in “Ductwork Schedule”.

2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

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. McGill AirFlow LLC.

2. MKT Metal Manufacturing.

3. Sheet Metal Connectors, Inc.

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC

Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard." See Duct Schedule in Part 3 for liner thickness.

1. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.

2. Coat insulation with antimicrobial coating.

3. Cover insulation with polyester film complying with UL 181, Class 1.

G. Inner Duct: Minimum 0.028-inch solid sheet steel.

H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Traverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

J. Sealing Requirements: Seal transverse joints in accordance with duct manufacturer recommendations.

2.4 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. General: Round ductwork may be either shop or factory fabricated. Flat-oval ductwork shall be factory fabricated.

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

1. McGill AirFlow LLC.

2. MKT Metal Manufacturing.

3. Sheet Metal Connectors, Inc.

4. Spiral Manufacturing Co., Inc.

5. Streimer Sheet Metal, Inc.

D. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

E. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

F. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

G. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

H. Sealing Requirements:

1. Concealed: Flanged, gasketed joints that meet seal requirements do not require separate duct sealant application.

2. Exposed: Seal non-flanged transverse joints with liquid duct sealer, specified herein, applied to male end fittings only, so that sealer is not visible when joint is assembled.

3. Welded Seam and Joints: Provide continuous air-tight seams and joints for ductwork, fittings, and connections where indicated in “Ductwork Schedule”.

2.5 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

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. McGill AirFlow LLC.

2. MKT Metal Manufacturing.

3. Sheet Metal Connectors, Inc.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and

Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
    b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard." See Duct Schedule in Part 3 for liner thickness.
    1. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
    2. Coat insulation with antimicrobial coating.
    3. Cover insulation with polyester film complying with UL 181, Class 1.
E. Inner Duct: Minimum 0.028-inch solid sheet steel.
F. Sealing Requirements: Seal transverse joints in accordance with duct manufacturer recommendations.

2.6 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
    1. Galvanized Coating Designation: G60.
    2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. No 2B finish, except where otherwise Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

D. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. 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.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.7 DUCT LINER

A. Flexible (Type I) or Rigid (Type II) Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

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

a. CertainTeed Corporation.

b. Johns Manville; a Berkshire Hathaway company.

c. Knauf Insulation.

d. Owens Corning.

2. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel, aluminum, stainless steel to match duct material; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Where multiple layers are required to obtain indicated thickness, provide inner perforated sheet metal duct.

2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.8 SEALANT AND GASKETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries.
2. McGill AirSeal LLC.
3. Carlisle HVAC Products.

B. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

C. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch w.g., positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch w.g., positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: 10-inch w.g., positive or negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

F. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

G. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.9 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved by Engineer.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

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, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 - Air Duct Accessories for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 DUCT SEALING

A. Provide Seal Class in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Clean duct surfaces prior to applying sealant.

C. Prior to application, verify that ducts are dry and within specified temperature limits.

D. Open ends of completed and overnight work-in-progress shall be sealed.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

C. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.

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.

3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. See Section 230548 - Vibration and Seismic Controls for HVAC.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 - Air Duct Accessories.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

C. Duct system will be considered defective if it does not pass tests and inspections.

3.8 START UP

A. Air Balance: Comply with requirements in Section 230593 - Testing, Adjusting, and Balancing for HVAC.

3.9 DUCT SCHEDULE

A. Common Ductwork Requirements.

1. Ductwork Material: Fabricate ducts with galvanized sheet steel except as otherwise indicated.

a. Intermediate Reinforcement: Match duct material.

2. Ductwork Construction: All ductwork single wall, except as otherwise indicated.

3. Pressure Class.

a. All Ductwork.

1) Where an automatically operated damper such as a fire and/or smoke damper or control damper can stop airflow: 100% of maximum achievable fan static pressure for fan and motor combination provided.

b. Ductwork serving a single inlets and outlet, except where otherwise scheduled:

1) 1-inch minimum.

c. Ductwork serving multiple inlets and outlets for one temperature control zone, and downstream of a terminal unit or other airflow control devices, except where otherwise scheduled.

1) 2-inch minimum.

d. Ductwork connected to fan and prior to first branch connection.

1) 120% of the fan design static pressure.

e. Ductwork connected to fan discharge shall be rated for positive pressure.

f. Ductwork connected to the fan inlet shall be rated for negative pressure.

g. Ductwork interconnecting two fans shall be rated for the largest of the two conditions.

4. Seal Class.

a. Class A in accordance ASHRAE 90.1.

5. Leakage Class.

a. Leakage Class 4 in accordance with ASHRAE Handbook " HVAC Systems and Equipment - 2012, Chapter 19, Table 2.

B. Specialized Ductwork Requirements: Following are unique requirement for specialized applications.

1. Exhaust Ducts:

a. Ducts Exhausting Showers.

1) Ductwork Material:

a) Type 304, stainless-steel sheet.

b) Aluminum sheet.

2) Ductwork Construction: Watertight seams and joints.

2. Outdoor-Air (Not, Heated, or Cooled) Ducts:

a. Outside-Air Ductwork.

1) Ductwork Construction: Single wall with internal liner or double walled with solid liner.

C. Single Wall Ductwork Liner Schedule:

1. Supply Air Ducts: Fibrous glass, Type I

a. Conditioned: 1 inch thick.

b. Unconditioned: 1-1/2 inches thick.

c. Outdoors: 2 inches thick.

D. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch:

1) Velocity less 600 fpm: Straight or 45-degree entry.

2) Velocity 600 fpm or Higher: 45-degree entry.

b. 45-degree entry.

c. Rectangular Main to Round Branch:

1) Velocity less 600 fpm: Straight, Conical tap or 45-degree entry.

2) Velocity less 1000 fpm: Conical tap or 45-degree entry.

3) Velocity 1000 fpm or Higher: 45-degree entry.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. Velocity less 1000 fpm: Conical tap or 45-degree lateral.

   b. Velocity 1000 fpm or Higher: Wye or 45-degree lateral fitting.

END OF SECTION

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SECTION 23 3300

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Accessories for duct systems.

1.2 ACTION SUBMITTALS

A. Provide submittals for products listed in the Product Table below in accordance with Section 230500 - General HVAC Provisions. Submittal requirements indicated by column number designation as follows:

1. Materials List.
2. Catalog Data.
3. Product Data.
4. Performance Data.
5. Wiring Diagrams.
6. Shop Drawings.
7. Installation Instructions.
8. Special Requirement listed herein.

PRODUCT TABLE	1	2	3	4	5	6	7	8
Manual Volume Dampers		x						
Remote Damper Operators		x						
Control Dampers			x	x				
Flexible Connectors		x						
Flexible Ducts		x						

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with 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.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.

2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

A. Acceptable Manufacturers.

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. Greenheck.

b. Nailor Industries Inc.

c. Pottorff.

d. Ruskin Company.

e. Trox USA Inc.

f. Young Regulator Company.

B. Round/Oval Single Blade Manual Volume Dampers:

1. Operating Conditions:

a. Maximum temperature: 180°F.

b. Maximum differential pressure: 1-inch water column.

c. Maximum air velocity: 2,000 fpm.

d. Standard leakage rating.

2. Suitable for horizontal or vertical applications.

3. Frames:

a. One piece 20-gauge construction. Material to match connected ductwork.

4. Blades:

a. Single blade.

b. 20-gauge construction. Material to match connected ductwork.

c. Stiffen damper blades for stability.

5. Blade Axles: Minimum 3/8-inch diameter plated steel or stainless steel, except stainless steel where adjacent ductwork is aluminum or stainless steel.

6. Bearings:

a. Oil-impregnated bronze, except stainless-steel sleeve where aluminum or stainless-steel frames are required.

b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Actuator:

a. Manual locking quadrant, except where remote damper operator is required.

b. Elevated platform for insulated duct mounting.

C. Single Blade Rectangular Manual Volume Dampers:

1. Operating Conditions:

a. Maximum temperature: 180°F.

b. Maximum differential pressure: 1-inch water column.

c. Maximum air velocity: 2,000 fpm.

d. Standard leakage rating.

2. Suitable for horizontal or vertical applications.

3. Frames: Hat-shaped, welded or gusset reinforced corners. 18-gauge construction. Material to match connected ductwork.

4. Blades:

a. Single blade.

b. 20-gauge construction. Material to match connected ductwork.

c. Stiffen damper blades for stability.

5. Blade Axles: Minimum ½ inch dia. plated steel or stainless steel, except stainless steel where adjacent ductwork is aluminum or stainless steel.

6. Linkages: Concealed in jamb outside or air stream.

7. Bearings:

a. Oil-impregnated bronze, except stainless-steel sleeve where aluminum or stainless-steel frames are required.

b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Actuator:

a. Manual locking quadrant, except where remote damper operator is required.

b. Elevated platform for insulated duct mounting.

D. Multiple Blade Rectangular Manual Volume Dampers:

1. Operating Conditions:
    a. Maximum temperature: 180°F.
    b. Maximum differential pressure: 4-inch water column.
    c. Maximum air velocity: 2,000 fpm.
    d. Standard leakage rating.
2. Suitable for horizontal or vertical applications.
3. Frames:
    a. Hat-shaped, welded or reinforced corners. Material to match connected ductwork.
        1) Galvanized steel or stainless steel: 16-gauge.
        2) Aluminum: 12-gauge.
    b. Mitered corners.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
    a. Opposed blade.
    b. Rolled Formed. Material to match connected ductwork.
        1) Galvanized steel or stainless steel: 16-gauge.
        2) Aluminum: 12-gauge.
    c. Stiffen damper blades.
5. Blade Axles: Minimum ½ inch diameter plated-steel or stainless-steel, except stainless-steel where adjacent ductwork is aluminum or stainless-steel.
6. Bearings:
    a. Oil-impregnated bronze, except stainless-steel sleeve where aluminum or stainless-steel frames are required.
    b. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
7. Actuator:
    a. Manual locking quadrant, except where remote damper operator is required.
    b. Elevated platform for insulated duct mounting.
8. Transitions: Provide factory transitions for connection to round and oval ductwork as required.

2.4 REMOTE DAMPER OPERATORS

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

1. Greenheck.

2. Pottorff.
3. Ruskin.
4. Ventfabrics, Inc.
5. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Actuator: Damper operator: steel rack and pinion.

D. Cable: Flexible steel casing and wiring.

E. Drive: Locking gear assembly with mounting hardware.

F. Accessories.

1. Wall-Box:

a. Mounting: Recessed.

b. Cover-Plate Material: Stainless-steel.

2.5 CONTROL DAMPERS

A. High Performance Control Dampers, Standard and Insulated.

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

a. Tamco.

2. Basis of Design:

a. Standard: Tamco Series 1000.

b. Insulated: Tamco Series 9000.

3. Operating Conditions: -40°F to 210°F.

4. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

a. Leakage Class: 1A at 1-inch w.g. static pressure differential.

5. Frames:

a. U shaped 6063-T5 extruded channel, 12-gaugethickness.

b. Blade Width: 4-inch or 6-inch as required.

c. Flanged connections on both sides.

d. Frame Seal: Extruded silicone mechanically fastened in integral slot within frame extrusion.

6. Blades:

a. Multiple opposed blade design, except parallel blade where otherwise indicated.

b. 6063-T5 extruded aluminum, 16-gaugethick dual skin air-foil with overlapping seal surface.

c. Blade Seal: extruded EPDM mechanically fastened in slot of overlapping blade extension.

d. Uninsulated, except where otherwise indicated. Insulated blades filled with expandable polyurethane foam.

7. Blade Axles: 7/16-inch hexagonal control shaft; galvanized steel; blade-linkage hardware of aluminum or zinc-plated steel.

8. Bearings:

a. Dual bearing system composed of a Celcon inner bearing, fixed around aluminum blade pivot pin, rotating within a polycarbonate outer bearing inserted in the frame.

2.6 FLEXIBLE CONNECTORS

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

1. Ductmate Industries, Inc.

2. Duro Dyne Inc.

3. Elgen Manufacturing.

4. Hardcast, Inc.

5. JP Lamborn Co.

6. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.

2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.

3. Service Temperature: Minus 40 to plus 200°F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.

2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.

3. Service Temperature: Minus 50 to plus 250 deg F.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.7 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Flexmaster U.S.A., Inc.
2. JP Lamborn Co.
3. McGill AirFlow LLC.
4. Thermaflex; a Flex-Tek Group company.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4,000 fpm.
3. Temperature Range: Minus 10 to plus 160°F.
4. Insulation R-value: R 4.2.

C. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4,000 fpm.
3. Temperature Range: Minus 20 to plus 175°F.
4. Insulation R-Value: R4.2.

D. Flexible Duct Elbow Support:
1. Manufacturers: Titus, Flexright, Thermaflex, FlexFlow, or equal.
2. Description: Radius forming brace to support flexible air ducts. UL 2043 listed.
3. Material" polypropylene brace, nylon cable ties to secure duct to boards.
a. Flexright.

2.8 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Provide low leakage control dampers as close as possible to the inlet of building exhaust fans as required by Oregon Energy Efficiency Specialty Code.

D. Install products in locations that are accessible and that will permit adjustment and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

E. Manual Volume Dampers:

1. Install in ductwork where shown on drawings and as required to properly balance airflow rates to values shown on Drawings. Provide damper for each air inlet and outlet.

2. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

3. Dampers must be accessible to allow inspection, adjustment, and replacement of components.

    a. Where manual actuators are not accessible for adjustment provide remote manual cable actuator. An actuator is not accessible if it is located more than 24 inches horizontally from an access point or more than 48 inches above an access point. Coordinate location of actuator drive assembly with Architect.

4. Do not compress or stretch the damper frame into the duct or opening. Damper shall move freely throughout full range of travel.

5. Dampers shall be rigid and secure not producing any audible noise due to vibration of components.

6. Set dampers to fully open position before testing, adjusting, and balancing.

7. Round Airflow Measurement and Balancing Dampers:

    a. Install with straight upstream and downstream ductwork in accordance with manufacturers recommendation.

    b. Install with test ports accessible for test equipment connection.

F. Remote Damper Operators.

1. Drive units: Where operators are associated with individual inlet or outlets, locate drive unit within associated grille or diffuser where appropriate. Otherwise, provide recessed wall/ceiling recessed drive units with cover plates.

2. Coordinate location of actuator drive assembly with Architect.

G. Control Dampers.

1. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.

2. Install smooth transitions, not exceeding 15 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact on performance.

3. Unless specifically designed for vertical blade application, dampers mounted with blades horizontal.

4. For duct-mounted and equipment-mounted dampers installed outside of equipment with flanged connections. Install in a visible and accessible indication of damper position from outside.

5. Seal between damper frame and ductwork and between multiple damper sections to prevent leakage around perimeter of damper.

6. Provide a minimum of one damper actuator per damper section.

7. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

8. Seal penetrations made in fire-rated and acoustically rated assemblies.

9. Service Access:

a. Dampers and actuators shall be accessible for visual inspection and service.

b. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator.

H. Flexible Connectors.

1. Install flexible connectors to connect ducts to equipment.

2. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

3. Provide connectors at equipment connections for all equipment that has vibration isolation supports.

4. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

I. Flexible Ductwork.

1. Install in professional manner with straight sections that do not bend or sagging. Turning angle shall not exceed 30 degree unless supported by a Flexible Duct Elbow Support. Maximum length of 48-inchs or as detailed on Drawings.

2. Provide flexible duct for final connection to diffusers and grilles where shown on and as detailed on drawings.

3. Do not use flexible ductwork for ASHRAE Class 3 or 4 exhaust air applications.
4. Connect flexible ducts to metal ducts with tape and draw bands.
    a. Tape inner duct liner to ductwork.
    b. Secure inner duct liner with nylon draw strap.
    c. Secure outer liner with nylon draw strap.

J. Test Holes.

1. Install test holes at fan inlets and outlets, coil inlets and outlets, and elsewhere as indicated.

3.2 APPLICATION

A. Manual Volume Dampers:

1. Material: Volume damper construction frame and blade material shall match material of connected ductwork.
2. Type:
    a. Round/Oval Single Blade Manual Volume Dampers: All round ductwork 20-inch diameter and below.
    b. Round Multiple Blade Manual Volume Dampers: All round ductwork greater than 20-inch diameter in exposed or concealed locations.
    c. Rectangular Single Blade Manual Volume Dampers: Rectangular ductwork where largest cross-sectional dimension is 18-inches and below.
    d. Rectangular Multiple Blade Manual Volume Dampers:
        1) Round or oval ductwork greater than 20-inch diameter located in concealed locations. Provide rectangular to round transition for connecting to round ductwork.
        2) Rectangular or oval ductwork where largest cross-sectional dimension greater than 18-inches. Provide rectangular to oval transition for connecting to oval ductwork.

B. Control Dampers.

1. Roof curb isolation dampers.
    a. Damper Type: High Performance Control Dampers, Insulated.
    b. Damper Width: 4-inch.
    c. Blade Action: Opposed.
    d. Blade Orientation: Parallel to longest dimension.

C. Flexible Connectors.

1. Indoor system: All indoor applications, except where otherwise required.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper prior to covering work or limiting access for inspection.

B. Control-Damper Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check dampers for proper location and accessibility.
3. Verify that control dampers are installed correctly for flow direction.
4. Verify that proper blade alignment, either parallel or opposed, has been provided.
5. Verify that damper frame attachment is properly secured and sealed.
6. Verify that damper actuator and linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that damper blade travel is unobstructed.
9. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

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SECTION 23 3423

HVAC POWER VENTILATORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Centrifugal roof ventilators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Prefabricated roof curbs.

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.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Factory quality-control-report:

1. Fan Vibration Testing Report.

1.4 FACTORY QUAILITY CONTROL

A. Vibration: Each fan shall be vibration tested before shipping, as an assembly, in accordance with AMCA 204-05. Each assembled fan shall be test run at the factory at the specified fan operating conditions. Vibration signatures shall be taken on each fan bearing in the horizontal, vertical, and axial directions. The maximum allowable fan vibration level at the design conditions when the fan is rigidly mounted shall be as follows:

1. Motor hp < 0.2: 0.5 in./sec. peak velocity.
2. Motor hp > 0.2 and less than 5.0: 0.2 in./sec. peak velocity.
3. Motor hp > 5.0 with spring isolation: 0.15 in./sec. peak velocity.
4. Motor hp > 5.0 with neoprene mounts: 0.08 in./sec. peak velocity.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Seismic Performance: HVAC power ventilators shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. See Section 230548 - Vibration and Seismic Controls for HVAC.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.

2.2 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

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

1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. New York Blower Company (The).
4. PennBarry.

5. Twin City Blower.

B. Housing: Downblast; removable spun-aluminum dome or square top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Direct-Driven Fans:

1. Motor: Permanently lubricated, fully modulating, variable speed, electrically commutated Comply with requirements in Section 230513 - Common Motor Requirements for HVAC Equipment.

2. Vibration isolation: Neoprene mounting.

3. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
2. Shutoff Dampers: Parallel-blade dampers mounted in curb base with electric actuator, Refer to 23 33 00 - Air Duct Accessories, Control Dampers and 23 09 25 BAS Field Mounted Devices for HVAC, Actuators.
3. Mounting Pedestal: Galvanized steel with removable access panel.

F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base. Comply with requirements in 23 05 00 - General HVAC Provisions, Roof Curbs, Bases, and Rails without integral vibration Isolation.

1. Configuration: Compatible with roofing systems. Coordinate with Architectural. Manufactured to accommodate roof slope.

2. Overall Height: 16 inches.

3. Damper tray.

4. Sound Curb: Curb with sound-absorbing insulation.

5. Hinged sub-base to provide access to damper or as cleanout for grease applications.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

A. Install power ventilators level and plumb.

B. Equipment Mounting:

1. Roof Mounted Units: Install fans on roof curbs or as otherwise detailed on drawings. Comply with requirements in 23 05 00 - General HVAC Provisions, Roof Curbs, Bases, and Rails without integral vibration Isolation.

2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 - Vibration and Seismic Controls for HVAC.

C. Install units with clearances for service and maintenance.

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories.

B. Provide shutoff dampers for each exhaust outlet in accordance with Code.

3.3 STARTUP SERVICE:

A. 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. Adjust damper linkages for proper damper operation.

7. Verify lubrication for bearings and other moving parts.

8. 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.

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.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Operate fan through full speed control range. Note any frequencies where excessive vibration occurs. Adjust motor controller to remove frequencies with excessive vibration. Refer to 23 05 14 - Common Motor Control Requirements for HVAC Equipment.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION

SECTION 23 3713

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diffusers.
2. Grilles.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

PART 2 PRODUCTS

2.1 COMMON REQUIREMENTS

A. Source Quality Control.

1. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following, unless specifically stated otherwise:

1. Anemostat Products; a Mestek company.
2. Krueger.
3. Nailor Industries Inc.
4. Price Industries.
5. Titus.

2.2 RECTANGULAR AND SQUARE CEILING DIFFUSERS

A. Square and Rectangular Neck Louvered Diffusers SD-1.

1. Basis of Design: Titus TDC.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Duct Inlet: Square or rectangular, size as shown on Drawings.
5. Pattern: Four-way core style, or as shown on drawings. Provide adjustable pattern controller to adjust vertical to horizontal blow pattern where shown on Drawings
6. Mounting:

a. Surface: Flush, Titus Type 1

b. Suspended Ceiling: Flush, border type and module size compatible with ceiling system.

2.3 RETURN GRILLES

A. Fixed Blade Grille RG/EG-1.

1. Basis of Design: Titus 350 RL/RS.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Blade Arrangement: 35-degree blade deflection. Spaced 3/4 inch apart. Blades parallel to long dimension if installed in ceiling or horizontal position. Blades parallel to floor if installed in wall or vertical position.
5. Frame: 1-1/4 inches wide.
6. Mounting:
   a. Surface: Countersunk screw.
   b. Suspended Ceiling: Flush, border type and module size compatible with ceiling system.
   c. Exposed: Countersunk screw.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Mounted devices tight to finished surface.

3.3 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 3723

HVAC GRAVITY VENTILATORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Louvered-penthouse ventilators.
2. Hooded ventilators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. For louvered-penthouse ventilators specified to bear AMCA seal, include printed catalog pages, showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For gravity ventilators.

1. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
2. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates for ventilators, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 PRODUCTS

2.1 FABRICATION

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located

and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.2 HOODED VENTILATORS

A. Description: Hooded round penthouse for intake and relief air.

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

1. Greenheck Fan Corporation.

2. Loren Cook Company.

3. PennBarry.

C. Source Limitations: Obtain hooded ventilators from single manufacturer.

D. Construction:

1. Material: Aluminum, of thickness required to comply with structural performance requirements, but not less than 0.063-inch-thick base and 0.050-inch-thick hood; suitably reinforced.

2. Insulation: Mineral-fiber insulation and vapor barrier.

3. Bird Screening: Galvanized-steel, 1/2-inch-square mesh wire.

E. Dampers:

1. Location: Curb damper tray.

2. Control: Motorized.

3. Tray: Provide damper tray or shelf with opening 33 inches of size indicated.

2.3 MATERIALS

A. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.

2. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Secure gravity ventilators to roof curbs with zinc-plated hardware, that comply with the wind and seismic fastening requirements. Use concealed anchorages where possible. Refer to Section 07 72 00 - Roof Accessories Division 07.

C. Install gravity ventilators with clearances for service and maintenance.

D. Install perimeter reveals and openings of uniform width for sealants and joint fillers,

as indicated.

E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 07 92 00 - Joint Sealants Division 07 for sealants applied during installation.

F. Label gravity ventilators according to requirements specified in Section 23 05 53 - Identification for HVAC Piping and Equipment.

G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes, so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

I. Refer to Section 07 72 00 - Roof Accessories Division 07 for flashing and counterflashing of roof curbs.

3.2 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION

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SECTION 23 4100

PARTICULATE AIR FILTRATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pleated panel filters.
2. Side-service housings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Product Test Reports: For each filter, for tests performed by manufacturer and witnessed by a qualified testing agency.

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 MAINTENANCE MATERIALS SUBMITTALS

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

1. Provide one complete set(s) of filters for each filter bank. Filters shall be clean at date of Substantial Completion. Filters furnished herein shall be in addition to those provided to replace filters used during construction.

1.5 QUALITY ASSURANCE

A. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

B. Comply with NFPA 90A and NFPA 90B.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean, dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical

damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

PART 2 PRODUCTS

2.1 PLEATED PANEL FILTERS

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. AAF/Flanders.
    b. Camfil Farr.
    c. UL Class establishes smoke and flammability limits according to two classifications. Class 1 is essentially non-flammable and produces negligible smoke. Class 2 filters burn moderately and smoke moderately. Class 2 filters meet mechanical code for HVAC systems and are the SWE standard. Class 1 would be selected only for special applications where smoke could damage the area served. If Class 1 is selected, the spec writer should review the spec to make sure it works.

B. Filter Unit Class: UL 900, Class 2.

C. Media: Cotton and synthetic fibers coated with nonflammable adhesive.

1. Adhesive shall have a VOC content of 80 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."
3. Media shall be coated with an antimicrobial agent.
4. Separators shall be bonded to the media to maintain pleat configuration.
5. Welded wire grid shall be on downstream side to maintain pleat.
6. Media shall be bonded to frame to prevent air bypass.
7. Support members on upstream and downstream sides to maintain pleat spacing.

D. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

F. Capacities and Characteristics:

1. Designation: F-1.
    a. Face Dimensions: As required to accommodate filter frame or housing.
    b. Depth: 2 inch as required to match filter housing.
    c. Initial Pressure Drop: 0.33-inches w.g. at 500 fpm.
    d. Final Resistance: 1 inch-w.g. at 500 fpm.
    e. Maximum Rated Pressure Drop: 2-inches w.g.
    f. MERV Rating: 8 when tested according to ASHRAE 52.2.

2.2 SIDE-SERVICE HOUSINGS

A. Description: Factory-assembled, side-service housings, constructed of 16-gauge galvanized steel welded joints with flanges to connect to duct or casing system. Provide independent tracks for prefilters and final filters. Similar to AAF SurePleat.
    1. Manufacturers: Subject to compliance with requirements, provide products by the following:
        a. AAF/Flanders.
        b. Camfil Farr.

B. Access Doors: Hinged, with continuous gaskets on perimeter and positive-locking devices and arranged so filter cartridges can be loaded from either access door.

C. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.

D. Static Pressure Ports: 1/8” NPT male ports to facilitate pressure drop measurements across filter.

E. Capacities and Characteristics:
    1. Designation: FH-1.
        a. Pressure Rating: +/- 6.0 inches w.g.
        b. Airflow Rate: 800 cfm.
        c. Dimensions: 15 inches high x 23.375 inches wide.
        d. Filter Quantity: 1, 24-inch x 12-inch filters.
        e. Access Door: Location as shown on drawings.
        f. Final Filter Type: F-1
        g. Final Filter Depth: 2 inches

PART 3 EXECUTION

3.1 INSTALLATION

A. Sizing:
    1. Select filter frames and housing to allow use of standard, readily available filter sizes.
    2. Metric size filters not acceptable.

B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

C. Install filters in position to prevent passage of unfiltered air.

D. 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.

F. Filters shall fit in racks without bending, distortion, or modification.

3.2 APPLICATION

A. Install filter frame in return duct upstream from inlet to each fan coil unit.

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

SECTION 23 8129

VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes complete Variable Refrigerant Flow HVAC system(s) including, but not limited to, delegated design and outdoor units, fan coil units, piping, and control components to make a complete operating system(s) according to requirements indicated.

1.2 DEFINITIONS

A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.

B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

C. VRF: Variable refrigerant flow.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.

4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.

5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit.

6. Include description of control software features.

7. Include refrigerant type and data sheets showing compliance with requirements indicated.

8. Indicate location and type of service access required.

B. Shop Drawings: For VRF HVAC systems.

1. Include plans, elevations, sections, and mounting 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 and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.

4. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittals:

1. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.

2. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.

3. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

2. Factory-Authorized Service Representative Qualifications.

B. Seismic Qualification Data: Certificates, for equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Filters:

a. One set(s) for each unit with replaceable filters.

1.7 QUALITY ASSURANCE

A. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.

2. In-place facility located within 100 miles of Project.

3. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.
4. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
5. Service and maintenance staff assigned to support Project during warranty period.
6. Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience. Demonstrated past experience with products being installed for period within three consecutive years before time of bid.
5. Installers shall have staffing resources of competent, trained, and experienced full-time employees that are assigned to execute work according to schedule.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period. Manufacturer’s factory trained service professional shall perform all warranty service work.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Daikin Applied.
2. LG Electronics USA, Inc.; LG Electronics Inc.

B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

1. Indoor and outdoor units, including accessories.
2. Controls and software.
3. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

A. Direct-expansion VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units,

HRCUs, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.

1. Two-pipe system design.
2. System(s) operation, heat pump as indicated on Drawings.
3. Each system with one refrigerant circuit shared by all indoor units connected to system.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.

D. ASHRAE Compliance:

1. ASHRAE 15: For safety code for mechanical refrigeration.
2. ASHRAE 62.1: For indoor air quality.
3. ASHRAE 135: For control network protocol with remote communication.
4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design complete and operational VRF HVAC system(s) complying with requirements indicated.

1. Provide complete design of variable refrigerant flow system including equipment, piping, and wiring as specified hereunder.
    a. System shall provide heating, cooling, air flow, and supply air temperature performance as scheduled on Drawings.
    b. Systems shall be designed to conform to thermal zoning arrangement shown on Drawings.
    c. Refrigerant piping shall be designed by the contractor. Pipe size and routing shown on drawings is approximate. Contractor to design piping size, length, routing, slope, connections, oil traps, and other details in accordance with Manufacturers recommendations.
    d. System configuration, equipment, pipe sizing, and electrical requirements shown on Drawings are for the basis of design systems and equipment. The Contractor must design system to meet functional and performance requirements and is responsible for all costs associated with variations in weight, arrangement, dimensions, or capacity for actual equipment furnished.
    e. VRF system design shall be completed, submitted and approved prior to beginning work. Beginning work constitutes acceptance of existing conditions. The contractor is responsible for any costs for changes related to work perform prior to date of submittal approval and related to modifications to accommodate existing conditions.
2. Provide system refrigerant calculations.

a. Refrigerant concentration limits shall be within allowable limits of ASHRAE 15 and governing codes.

b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.

3. Include a mechanical ventilation system and gas detection system as required to comply with ASHRAE 15 and governing codes.

4. System Refrigerant Piping and Tubing:

a. Arrangement: Arrange piping to interconnect indoor units and outdoor unit(s) in compliance with manufacturer requirements and requirements indicated.

b. Routing: Conceal piping above ceilings and behind walls to maximum extent possible.

c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated. Consider requirements to accommodate future change requirements.

5. System Controls:

a. Network arrangement.

b. Network interface with other building systems.

c. Product selection.

d. Sizing.

B. Service Access:

1. Provide and document service access requirements.

2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations.

3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.

4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.

C. System Design and Installation Requirements:

1. Design and install systems indicated according to manufacturer's recommendations and written instructions.

2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.

3. Isolation of Equipment: Provide isolation valves to isolate each indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.

4. Capable of heating operation at 0°F dry bulb ambient temperature without an auxiliary heat source.

5. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within range acceptable to manufacturer and the following range of outdoor-unit rated capacity:
    a. Not less than 60 percent.
    b. Not more than 120 percent.
6. Provide sub-cooling to ensure that refrigerant does not flash at indoor units.
7. Design system to operate with a variable saturated suction temperature setpoint that is reset based on system load. Design indoor units that are located in internal spaces or provided cooling for processes where design loads may occur when system loads are not at maximum to provide design capacity with maximum suction temperature reset.

D. System Turndown: Stable operation down to 29 percent of outdoor-unit module capacity.

E. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.

F. System Auto Restart: Automatically restart operation after an electrical power interruption and will maintain control setpoints and parameters.

G. Indoor Conditions.
1. Suitable for operation with the following indoor conditions.
    a. Cooling operating range: 57°F to 77°F.
    b. Heating operating range: 59°F to 80°F.
    c. Maintain space temperature setpoints within +/- 2oF.

H. Outdoor Conditions:
1. Suitable for operation in cooling mode with the following outdoor ambient conditions.
    a. Maximum System Operating Outdoor Temperature: 115oF.
    b. Minimum System Operating Outdoor Temperature: 23oF.
2. Suitable for operation in heating mode with the following outdoor ambient conditions.
    a. Maximum System Operating Outdoor Temperature: 77oF.
    b. Minimum System Operating Outdoor Temperature: 0oF.
3. Design equipment and supports to withstand wind loads of governing code and ASCE/SEI 7.
    a. Design equipment and supports to withstand snow and ice loads of governing code and ASCE/SEI 7.
    b. Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.

I. Seismic Performance: VRF HVAC system(s) shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.
3. Per ASCI/SEI 7.

J. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.
1. Indoor: See Drawings.
2. Outdoor: See Drawings.

K. Capacities and Characteristics: As indicated on Drawings.

2.4 OUTDOOR, AIR-SOURCE HEAT-PUMP UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
1. Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. All units installed shall be from the same product development generation.

B. Cabinet:
1. Galvanized steel and coated with a corrosion-resistant finish.
a. Coating with documented salt spray test performance of 1000 hours according ASTM B 117 surface scratch test (SST) procedure.
2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:
1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:
a. High refrigerant pressure.
b. Low oil level.
c. High oil temperature.
d. Thermal and overload.
e. Voltage fluctuations.
f. Phase failure and phase reversal.

g. Short cycling.

3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

D. Condenser Coil Assembly:

1. Plate Fin Coils:
   a. Casing: Aluminum, galvanized, or stainless steel.
   b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
   c. Tubes: Copper, of diameter and thickness required by performance.
2. Corrosion Protection: Coating with documented salt spray test performance of 1000 hours according ASTM B 117 surface scratch test (SST) procedure.

E. Condenser Fan and Motor Assembly:

1. Fan(s): Propeller type.
   a. Direct-drive arrangement.
   b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
   c. Statically and dynamically balanced.
2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.
6. Vibration Control: Integral isolation to dampen vibration transmission.

F. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:
   a. Refrigerant suction temperature.
   b. Refrigerant discharge temperature.

c. Outdoor air temperature.

d. Refrigerant high pressure.

e. Refrigerant low pressure.

4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, manual operation mode, night setback control, power consumption display, run test switch, and equalize run time between multiple same components.
   a. Saturated Suction Temperature Setpoint Reset: Reset suction temperature setpoint from 42 deg F to 48 deg F based on system load with minimum and maximum setpoint limits.
5. Communication: Network
6. Communication with indoor units and other outdoor unit(s).
7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

G. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

H. Unit Hardware: Zinc-plated steel, or stainless steel.

I. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Factory Charge: Dehydrated air or nitrogen.
4. Testing: Factory pressure tested and verified to be without leaks.

2.5 INDOOR FAN COIL UNITS

A. Common Fan Coil Unit Requirements.

1. General: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections as indicated.
2. Casing.
   a. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.

b. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork where indicated.

c. Mounting: Manufacturer-designed provisions for field installation.

d. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

3. Refrigerant Coil Assembly:

a. Coil Casing: Aluminum, galvanized, or stainless steel.

b. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.

c. Coil Tubes: Copper, of diameter and thickness required by performance.

d. Expansion Valve: Electronic modulating type with linear or proportional characteristics.

e. Unit Internal Tubing: Copper tubing with brazed joints.

f. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.

g. Field Piping Connections: Manufacturer's standard.

h. Factory Charge: Dehydrated air or nitrogen.

i. Testing: Factory pressure tested and verified to be without leaks.

4. Drain Assembly:

a. Pan: Non-ferrous material, with bottom sloped to low point drain connection.

b. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation five feet above top of cabinet. Pump is not required if condensate can be drain to an approved location by gravity.

c. Field Piping Connection: Non-ferrous material.

5. Fan and Motor Assembly:

a. Fan(s):

1) Direct-drive arrangement.

2) Single or multiple fans connected to a common motor shaft and driven by a single motor.

3) Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.

4) Wheels statically and dynamically balanced.

b. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.

c. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

d. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 65 percent.

e. Vibration Control: Integral isolation to dampen vibration transmission.

6. Filter Assembly:
   a. Filter holding frames: Provide holding frames that are duct mounted.
      1) Duct-mounted: Field installed. Conform to 23 41 00 - Particulate Air Filtration, Filter Holding Frames.
      2) Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
      3) Performance:
   b. Filter Media.
      1) Type: Replaceable or washable as indicated. Conform to 23 41 00 - Particulate Air Filtration, Pleated Filters.
         a) Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
         b) Washable: Manufacturer's standard filter with antimicrobial treatment.
      2) Efficiency: MERV rating as indicated.
7. Unit Accessories: Provide unit accessories where indicated, required by sequence of operations, or as where on drawings.
8. Unit Controls:
   a. Enclosure: Metal, suitable for indoor locations.
   b. Factory-Installed Controller: Configurable digital control.
   c. Field-Customizable I/O Capability:
      1) Analog Inputs: Two for use in customizable control strategies.
      2) Digital Inputs: Two for use in customizable control strategies.
      3) Digital Outputs: Two for use in customizable control strategies.
   d. Features and Functions:
      1) Self-diagnostics.
      2) Time delay.
      3) Auto-restart.
      4) External static pressure control.
      5) Auto operation mode.
      6) Manual operation mode.
      7) Filter service notification.
      8) Power consumption display.
      9) Drain assembly high water level safety shutdown and notification.
      10) Run test switch.

e. Communication: Network communication with other indoor and outdoor units.

f. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

g. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

9. Unit Electrical:

a. Enclosure: Metal, suitable for indoor locations.

b. Field Connection: Single point connection to power unit and integral controls.

c. Disconnecting Means: Factory-mounted circuit breaker or switch.

d. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

e. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

f. Raceways: Enclose line voltage wiring in metal raceways.

2.6 SYSTEM REFRIGERANT

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.

2. ASHRAE 34, Class A1 refrigerant classification.

3. R-410a.

2.7 SYSTEM PIPING

A. Refrigerant Piping: Comply with requirements in Section 232300 - Refrigerant Piping for system piping requirements.

B. Refrigerant Isolation Ball Valves:

1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap. Valve components compatible with refrigerant and oil used.

a. Integral service port.

2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.

3. Valve Connections: Brazed.

C. Piping Covers.

1. Acceptable 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. Fortress +

b. Diversitech, SpeediChannel.

c. Mitsubishi Line-Hide,

d. Slimduct.

2. Duct:

a. Two-piece, UV resistant, paintable, PVC or Resin Composite.

b. Base mounting section with snap-on top cover.

c. Size: Rectangular profile sized to contain insulated refrigerant piping and condensate drain piping.

d. Fittings: Same material as duct. Fittings as required for routing shown on drawings.

e. Color: White.

2.8 SYSTEM CONTROLS

A. General Requirements:

1. Network: Indoor units, HRCUs, and outdoor units shall include integral controls and connect through a manufacturer-selected control network.

2. Network Communication Protocol: Manufacturer proprietary or open control communication between interconnected units.

3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:

a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.

b. Integration devices shall be connected to local uninterruptible power supply unit(s) to provide at least 5 minutes of battery backup operation after a power loss.

c. Integration shall include control, monitoring, scheduling, and change of value notifications.

4. Operator Interface:

a. Operators shall interface with system and unit controls through the following:

1) Operator interfaces integral to controllers.

2) Integration with Building Automation System.

b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:

1) On/off control.

2) Temperature set-point adjustment.

B. Controllers for Indoor Units:

1. On/Off: Turns indoor unit on or off.

2. Hold: Hold operation settings until hold is released.

3. Operation Mode: Cool, Heat, Auto, Fan Only, and Setback.

4. Temperature Display: 1-degree increments.

5. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments.
6. Fan Speed Setting: Select between available options furnished with the unit.
7. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
8. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
9. Service Run Tests: Limit use by service personnel to troubleshoot operation.
10. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
11. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
12. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.
13. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

2.9 SYSTEM CONTROL CABLE

A. Cable Rating: Listed and labeled for application according to NFPA 70.

B. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for control wiring and cable raceways.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:

1. Maintain manufacturer's recommended clearances for service and maintenance.
2. Maintain clearances required by governing code.

B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, which are not factory mounted.

C. Equipment Restraint Installation: Install equipment with seismic-restraint device. Refer to requirements for seismic-restraint devices specified in Section 230548 - Vibration and Seismic Controls for HVAC.

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch.

C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

G. Install floor-mounted units on support structure indicated on Drawings.

H. Attachment: Install hardware for proper attachment to supported equipment.

3.4 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Install outdoor units on support structures indicated on Drawings.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings. Piping on drawings show routings only and do not indicate size or quantity of piping.

B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping and tubing to permit valve servicing.

F. Install piping and tubing at indicated slopes.

G. Install piping and tubing free of sags.

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

I. Install piping and tubing to allow application of insulation.

J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

K. Condensate Drain Piping:

1. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.

2. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping.

3. Gravity Drains: Slope piping from unit connection toward drain termination at a constant slope of not less than one percent.

4. Pumped Drains: If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.6 INSTALLATION OF REFRIGERANT PIPING

A. Comply with requirements in Section 232300 - Refrigerant Piping for system piping requirements.

B. Install refrigerant piping according to ASHRAE 15 and governing codes.

C. Install piping as short and direct as possible, with a minimum number of joints and fittings.

D. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

E. Install refrigerant piping and tubing in protective conduit where installed belowground.

F. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

G. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:

1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.

2. Install horizontal suction lines with a uniform slope downward to compressor.

3. Install traps to entrain oil in vertical runs.

4. Liquid lines may be installed level.

H. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

3.7 HANGERS AND SUPPORTS

A. Comply with Comply with requirements in Section 230548 "Vibration and Seismic

Controls for HVAC" for seismic restraints.

3.8 ELECTRICAL INSTALLATION

A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.

B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.

1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.

C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

E. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

F. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or revised in this Section.

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.

2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

a. First Visit: Kick-off meeting.

b. Second Visit: At approximately 50 percent completion of system(s).

c. Third Visit: Final inspection before system startup.

3. Kick-off Meeting:

a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.

b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.

c. Meeting shall cover the following as a minimum requirement:

1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.

2) Manufacturer's installation requirements specific to systems being installed.

3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.

4) Required field activities related installation of VRF HVAC system.

5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.

4. Site Visits: Activities for each site visit shall include the following:

   a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.

   b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.

   c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.

   d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.

   e. Issue a report for each visit, documenting the visit.

      1) Report to include name and contact information of individual making the visit.

      2) Date(s) and time frames while on-site.

      3) Names and contact information of people meeting with while on-site.

      4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:

   a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according to manufacturer's requirements and ready for final inspection.

   b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.

   c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.

   d. Inspection reports for indoor units shall include, but not be limited to, the following:

      1) Unit designation on Drawings.

2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity settings and readings within an acceptable range.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Unit airflow direction within an acceptable range.
19) If applicable, fan external static pressure setting.
20) Filter type and condition acceptable.
21) Noise level within an acceptable range.
22) Refrigerant piping properly connected and insulated.
23) Condensate drain piping properly connected and insulated.
24) If applicable, ductwork properly connected.
25) If applicable, external interlocks properly connected.
26) Remarks.

e. Inspection reports for outdoor units shall include, but not be limited to, the following:
1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.

8) Wiring and power connections correct.

9) Line-voltage reading(s) within acceptable range.

10) Wiring and controls connections correct.

11) Low-voltage reading(s) within an acceptable range.

12) Condensate removal acceptable.

13) Noise level within an acceptable range.

14) Refrigerant piping properly connected and insulated.

15) Condensate drain piping properly connected and insulated.

16) Remarks.

f. Installer shall provide manufacturer with the requested documentation and technical support during inspection.

g. Installer shall correct observed deficiencies found by the inspection.

h. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.

i. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.

j. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

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

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.

2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.5 times VRF HVAC system operating pressure, but not less than 600 psig, using dry nitrogen.

3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.

4. Prepare test report to record the following information for each test:
    a. Name of person starting test, company name, phone number, and e-mail address.
    b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
    c. Detailed description of extent of tubing tested.
    d. Date and time at start of test.
    e. Test pressure at start of test.
    f. Outdoor temperature at start of test.
    g. Name of person ending test, company name, phone number, and e-mail address.
    h. Date and time at end of test.
    i. Test pressure at end of test.
    j. Outdoor temperature at end of test.
    k. Remarks:
5. Submit test reports for Project record.

D. Refrigerant Tubing Evacuation Testing:
1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour(s) with no change.
4. Prepare test report to record the following information for each test:
    a. Name of person starting test, company name, phone number, and e-mail address.
    b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
    c. Detailed description of extent of tubing tested.
    d. Date and time at start of test.
    e. Test pressure at start of test.
    f. Outdoor temperature at start of test.
    g. Name of person ending test, company name, phone number, and e-mail address.
    h. Date and time at end of test.
    i. Test pressure at end of test.
    j. Outdoor temperature at end of test.
    k. Remarks:
5. Submit test reports for Project record.

6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.

2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.

3. System manufacturer’s representative shall witness system refrigerant charging.

4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Cut out joint.

G. Products will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports.

3.10 STARTUP SERVICE

A. Engage a VRF HVAC system Factory-Authorized Service Representative to perform system(s) startup service.

1. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.

2. Complete startup service of each separate system.

3. Complete system startup service according to manufacturer's written instructions.

B. Startup checks shall include, but not be limited to, the following:

1. Check control communications of equipment and each operating component in system(s).

2. Check each indoor unit's response to demand for cooling and heating.

3. Check each indoor unit's response to changes in airflow settings.

4. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.

5. Check sound levels of each indoor and outdoor unit.

C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:

1. After completion of startup service, manufacturer shall issue a report for each separate system.

2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.

3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.

    a. All available system operating parameters shall be included in the information submitted.

E. Witness:

1. Invite Owner's Authorized Representative to witness startup service procedures.

2. Provide written notice not less than 10 business days before start of startup service.

3.11 ADJUSTING

A. Adjust initial airflow settings and discharge airflow patterns.

B. Occupancy Adjustments: Adjust initial operating schedule for occupied and unoccupied periods as directed by Owner's Authorized Representative. When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

C. Program controller(s) to resume previous mode of operation after power failure.

D. Indoor Unit Controllers.

1. Adjust control mode to provide automatic switchover between heating and cooling.

2. Adjust fan operating to "Continuous" for occupied periods.

3. Adjust initial temperature set points for occupied and unoccupied periods as directed by Owner's Authorized Representative. Following are initial setpoints.

    a. Occupied Space Setpoints:

        1) Cooling: 75°F.

        2) Heating: 70°F.

    b. Unoccupied Space Setpoints:

        1) Cooling: 85°F.

        2) Heating: 60°F.

4. Adjust occupant override privileges including temperature setpoint adjustment ranges as directed by Owner's Authorized Representative.

3.12 PROTECTION

A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.

B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.

C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.

D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.13 DEMONSTRATION

A. Engage a VRF HVAC system manufacturer's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Instructor:

1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.

2. Instructor(s) shall have not less than three years of training experience with VRF HVAC system manufacturer and past training experience on at least three projects of comparable size and complexity.

C. Schedule and Duration:

1. Schedule training with Owner at least 20 business days before first training session.

2. Training shall occur before Owner occupancy.

3. Training shall be held at mutually agreed date and time during normal business hours.

4. Each training day shall not exceed four hours of training.

5. Perform not less than 4 total hours of training.

D. Location: Owner shall provide a suitable on-site location to host classroom training.

E. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.

F. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

G. Acceptance: Obtain written acceptance of Owner’s Authorized Representative that training is complete and requirements indicated have been satisfied.

END OF SECTION